Stairs, ramps and escalators

Inclusive design guidance

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cae Centre for Accessible Environments

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Contents

Foreword

As Chair of the British Standards Committee for Stairs and Walkways, I am delighted to have been asked to write the foreword to this guidance. I expect it will be a 'must-have' for all those responsible for ensuring the safe passage of people between different levels within and around buildings. This book pulls together the accessibility and safety requirements for stairs, steps, ramps and escalators, in a comprehensive and relevant way.

The earth is not flat and we do not build our buildings or landscapes in such a way that everything is on a single level. Instead we try to make efficient use of expensive land by creating buildings with many floors and by providing services under ground. While this continues, we will always need some method of enabling people to change between levels in order to take full advantage of our built environment. Such methods should be safe to use and accessible to as many users as possible.

Back in my formative years, *Doctor Who* highlighted how changes in level could be a physical barrier. When the daleks tried to exterminate everything in their path we all knew that you could easily get away by going up some stairs. I have heard that the modern dalek has found ways to overcome these problems, and so we are no longer safe from imminent annihilation. Now that I am older, I realise that this physical barrier, portrayed as the saviour of mankind, is a real barrier to many people. We have gone a long way towards considering the needs of users and providing alternative means of accessing different levels so that no area is off-limits to anyone who has any difficulty in climbing stairs. Hopefully this accessibility will continue to improve as we consider the needs of others in our designs.

I am still a strong advocate for stairs in buildings, and at present they are the most efficient way of getting lots of people out of buildings quickly. However, stairs can also be dangerous, causing injuries to many thousands of people in the UK each year. Considering how little time we spend on them, they are perhaps the most hazardous feature in most buildings. A lot of this hazard can be reduced by good design, and this book considers all the latest research to highlight good design. Ramps and escalators can also be hazardous if not designed correctly, and again this publication draws on the evidence to provide good, sound advice for making them safer. There will probably always be an element of risk associated with these building elements, especially through misuse or inappropriate behaviour, but we should be trying our best to reduce this risk to a reasonable level. Following the advice given here will help you to achieve this.

Mike Roys
Chair of B/208 Stairs and Walkways

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Glossary

Abbreviations

AD	Approved Document
BMS	building management system
BRE	Building Research Establishment
BS	British Standard
CCTV	closed-circuit television
CDM	Construction Design and Management Regulations
CIBSE	Chartered Institute of Building Service Engineers
CIE	Commission Internationale de l'Eclairage
CLG	Communities and Local Government
CMS	Central Monitoring Service
CoF	coefficient of friction
CPR	Construction Products Regulations
DDA	Disability Discrimination Act
DfT	Department for Transport
GRP	glass-reinforced plastic
HBN	Health Building Note
HSE	Health and Safety Executive
HSL	Health and Safety Laboratory
LRV	light reflectance value
LUL	London Underground Limited
PEEP	personal emergency evacuation plan
PTV	pendulum test value
PUWER	Provision and Use of Work Equipment Regulations 2008
PVC	polyvinylchloride
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations
SLL	Society for Light and Lighting
SRV	slip resistance value

Terms and definitions

Unless otherwise stated these have been taken from British Standards.

Steps, stairs and ramps

Note: in this document the terms ‘steps’ is used for external elements and ‘stairs/stairways’ for internal elements. A step is part of a flight of steps or stairs.

corduroy hazard warning surface	a form of tactile paving whose surface has raised ribs to warn visually impaired people of a potential hazard ahead (the ribs, spaced at 50mm between centres, are installed at right angles to the direction of travel and parallel with the step nosing)
flight	a continuous series of steps or ramp between two levels
going	the horizontal distance between two consecutive nosings, measured along the walking line; the horizontal distance between each end of a ramp flight
handrail	a component of stairs, steps or ramps that provides guidance and support at hand level; it may form the top rail of guarding (balustrading), be supported independently from guarding or be supported from a wall
landing	a level platform or part of a floor at the end of a flight, ramp or floor
nosing	the front edge portion of a tread or landing
ramp	length of inclined surface that provides access between two levels (an access route that has a gradient of 1:20 or steeper is assumed to be a ramp)
refuge	an area that is both separated from a fire by fire-resisting construction and provided with a safe route to a storey exit, thus constituting a temporarily safe space
rise	vertical distance between the horizontal upper surfaces of two consecutive treads, or between a tread and a floor or a tread and a landing; vertical distance between each end of a ramp flight
riser	the vertical component of a step between one tread and another or a landing above or below it
stair width	the surface width of a stair on plan perpendicular to the walking line of a stair (measured to the face of the enclosing wall, string, balustrade or upstand, whichever is closer to the walking line)
string	the side of the staircase that locates the treads and risers; an inner (closed) string is set against a wall and an outer (open) string is on the open side of a staircase (not a British Standard definition)
tread	the horizontal component of a step
winder	a step, generally wedge-shaped, with a tread that is wider at one end than the other; often used in spiral staircases

Escalators and moving walks

balustrade	part of the escalator/moving walk which ensures the user's safety by providing stability, protecting from moving parts and supporting the handrail
comb	a pronged section at each landing that meshes with the grooves
comb interface	the line at which the comb plate meets the moving pallets
comb plate	a platform at each landing to which the combs are attached (not a British Standard definition)
escalator	a power-driven, inclined, continuous moving stairway used for raising or lowering persons in which the user-carrying surface (such as steps) remains horizontal
moving walk	a power-driven installation for the conveyance of persons in which the user-carrying surface remains parallel to its direction of motion and is uninterrupted (using pallets or a belt)
skirting	the vertical part of the balustrade interfacing with the steps, pallets or belt

Other

illuminance	the amount of light falling on a surface, measured in lumens per square metre (lm/m^2) or lux (lx)
light reflectance value (LRV)	the total quantity of visible light reflected by a surface at all wavelengths and directions when illuminated by a light source (the greater the difference in LRV between surfaces, the easier it is for visually impaired people to distinguish them)
visual contrast (or contrast visually)	the perception of a difference visually between one surface or element of a building and another by reference to their light reflectance values (LRVs)

Introduction 1

1.1 Inclusive design

Inclusive design is a process that delivers an environment in which everyone can access and benefit from the full range of opportunities available to members of society.

It aims to remove barriers that create undue effort, separation or special treatment, and enables everyone – regardless of disability, age or gender – to participate equally, confidently and independently in mainstream activities with choice and dignity.

Inclusive design:

- places people at the heart of the design process
- responds to human diversity and difference
- offers dignity, autonomy and choice
- provides for flexibility in use

1.2 Context

Steps, stairs, ramps and escalators are a means of moving up or down between different levels externally or internally. These elements can present significant barriers and be a hazard to some members of society, particularly those with mobility or visual impairments, those with breathing difficulties, people with a fear of heights, and young children.

There are a significant number of accidents on steps, stairs and escalators, with very young and older people being the most vulnerable. In 1999 the Department of Trade and Industry estimated that there were 100,000 injuries and 100 fatalities on non-domestic stairs. The Health and Safety Executive provisional figure for 2008/9 for slips, trips and falls on stairs, under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR), is 6,039 reported incidents, representing about 13 per cent of all slip, trip and fall accidents, of which 1,821, about 30 per cent, were classed as major injuries. Since 2008, injuries involving stairs have been coded as falls rather than trips and slips, which makes comparison of the figures with previous years difficult. Taking this into account, it appears that the number of falls on steps and stairs is rising and the number of slips and trips is falling. After ladders, steps and stairs are the main agent for falls. The number of accidents on moving walks reported is very small: 19 between the years 2001 and 2005. London Underground Limited had 1,086 reported incidents in 2008/9, 51 per cent of which were on escalators and 21 per cent on stairs, totalling 72 per cent of all reported incidents. Similarly, the majority of incidents reported to Network Rail occur on stairs and escalators, the main causes being running and alcohol and drug abuse. In 2008 there were 983 incidents on stairs, a 20 per cent increase compared with 2006, and 495 incidents on escalators, which is a similar figure to previous years.

Escalators and moving walks present additional challenges of access and getting on or off a moving surface, which some people find difficult or frightening. Having moving parts also presents the risk of trapping of fingers, clothing and other items, which is the cause of many of the accidents reported. Their

metal composition and their sharp step edges mean that injuries are more likely to be severe if falls occur.

Many of these challenges and hazards can be mitigated by good design and detailing of these elements, together with regular and appropriate cleaning and maintenance, making them safer and more accessible for everyone using them.

1.3 About this handbook

This handbook covers the design and specification of steps/stairs, ramps, escalators and moving walks to meet the requirements for inclusive design in non-domestic buildings. Lifts are not covered as they do not share the same design issues as these other means of vertical access.

The handbook offers practical guidance to assist designers, specifiers, building owners and occupiers, building managers and facilities managers to understand and address the issues for the design, specification and operation of these elements. It covers the design issues common to steps/stairs, ramps, escalators and moving walks, and provides good practice technical guidance in relation to these issues for the design and specification of these elements in external and internal environments, and in different building types. Operational and maintenance issues, including cleaning, that need to be considered at the design stage are also indicated. The guidance refers to relevant legislation, Building Regulations and standards, and is supported by illustrations and case study examples that demonstrate the different issues and good practice solutions for different situations.

The handbook is structured to enable readers to 'dip into' it as they wish, as the guidance for each element can be used independently of the rest of the book if required. The design issues are covered in **Section 3** and good practice technical guidance on each element in external and internal environments is given in **Section 4**. The technical guidance given for each element is presented in a similar order to the design issues, so that it is easy to refer back to the relevant section in **Section 3**.

The regulatory framework 2

2.1 Building Regulations

All new developments are subject to approval under Building Regulations, in which case the provisions in the relevant Approved Documents, Technical Handbooks or Technical Booklets will be applicable. Improvements to existing buildings may or may not require approval under Building Regulations depending on the nature and extent of the work.

Steps, stairs and ramps are covered by the Building Regulations; escalators and moving walks are not, but are subject to other legislation on the supply, installation and maintenance of machinery (see **2.6–2.7** below).

2.1.1 England and Wales

Approved Document M: *Access to and use of buildings* (AD M), 2004 edition

This covers the design of external steps, ramps and handrails (Section 1) and internal stairs, ramps and handrails (Section 3) as a means of access into, and use of, a building.

It should be noted that BS 8300:2009 (see below) is the most recent guidance but this is not yet reflected in the Building Regulations, which has created some inconsistencies between the two.

Approved Document K: *Protection from falling, collision and impact* (AD K), the 1998 edition, amended 2000

This contains general guidance on stair and ramp design applicable where there are two or more steps of a rise greater that 380mm. Where there are any conflicts between AD K and AD M, the latter, being more recent, should take precedence.

Approved Document B (Fire Safety): *Volume 2 – Buildings other than dwellinghouses* (AD B), 2006 edition, amended 2007

This contains guidance on the use and design of stairs as a means of escape.

2.1.2 Scotland

Non-domestic Handbook 2007: Section 4 – *Safety*

The main guidance on stairs and ramps is contained in Section 4.3, *Stairs and ramps*, with additional guidance on external steps and ramps in subsection 4.1.3, *Accessible routes*.

Section 2, *Fire,* covers the use of stairs as a means of escape in subsections 2.9.10–12, 2.9.24 and 2.9.26.

2.1.3 Northern Ireland

Technical Booklet R: 2006 – *Access to and use of buildings*

This provides guidance on external steps and ramps in Section 2, *Access to a building*, and internal stairs and ramps in Section 4, *Access within a building*.

Technical Booklet H: 2006 – *Stairs, ramps, guarding and protection from impact*

This provides general guidance on the design of stairs, ramps and guarding.

Technical Booklet E: 2005 – *Fire Safety*

This covers stairs as a means of escape under *Vertical part of the escape route* in Section 1, *Means of escape*.

2.2 Disability Discrimination Acts 1995 and 2005

Steps, stairs, ramps, escalators and moving walks are 'physical features' under the Disability Discrimination Act 1995 (DDA). The design and detailing – such as the dimensions, visual and tactile identification, finishes and lighting – contribute significantly to their usability, safety and appearance, particularly for those with mobility or visual impairments.

New buildings should enable access to all parts of the premises and their environment for everyone, regardless of age, size, disability or encumbrance. For existing buildings, the DDA places duties on service providers, employers, providers of post-16 education and others to make **reasonable** adjustments to physical features where they present a potential barrier to access or the use of facilities. Buildings that have been constructed in accordance with the provision of AD M at the time are 'protected' from this requirement for a period of 10 years from the date of construction. Reasonable adjustments may involve the removal or alteration of a barrier, or the provision of an alternative means of access.

There is no definition of 'reasonable', and clear guidance is likely to evolve only from case law over time. The extent and nature of any adjustment will depend on the service being provided, the nature and size of the provider, the environment and type of building in question, its existing or proposed use, the need and potential alternatives for vertical access, and on other factors such as practicality, space constraints, the extent of disruption, the effectiveness of the adjustment, cost and the availability of finance. Each situation is likely to be unique and must be considered on its own merits. The duty is to make 'reasonable' adjustments, having taken into account all the relevant factors.

Changes in level via steps, stairs and escalators are significant barriers to people with mobility impairments, and can prevent them accessing part of a building; people with visual or other impairments, such as breathing difficulties, may also be inhibited. Providing alternative access by means of a suitable permanent ramp or lift would constitute a 'reasonable adjustment' under the Act. Where this is not possible for space or conservation reasons, alternative access via a secondary route or a portable ramp may be acceptable. In historic buildings where, after careful investigation, it can be demonstrated or justified that the provision of step-free access to floors above or below ground level is not possible, a virtual tour may be a 'reasonable adjustment'. At a more detailed level, the addition of suitable handrails to assist ambulant disabled people, or visually contrasting nosings to the steps and improved lighting to help those with visual impairments identify changes in level, would also be reasonable adjustments.

Duties under the DDA relate not only to the adjustment of physical features, but also to policies, practices and procedures – all of which could have a significant effect on the safety, accessibility and usability of steps, stairs, ramps, escalators and moving walks. These duties include cleaning, regular inspection and maintenance, and provision of information and assistance, if necessary.

2.3 The Workplace (Health Safety and Welfare) Regulations 1992

The aim of the Regulations is to ensure that workplaces meet the minimum health, safety and welfare needs of every member of the workforce. Several of the Regulations require things to be 'suitable', which means that circulation routes, facilities and equipment used by disabled people should meet their particular requirements.

Floor finishes and traffic routes are covered under Regulation 12. The regulation covers 'every floor in a workplace and the surfaces of traffic routes' and requires them to be of suitable construction, to have a surface that is even and slip resistant, and to have suitable drainage and no hole or slope that would present a risk to any person. All floors and traffic routes are required to be kept clear of obstructions and free from any substance that may cause a person to slip, trip or fall. All staircases are required to have 'suitable and sufficient handrails' and guarding as appropriate unless the handrails would obstruct the circulation. The Regulations say only that handrails should be considered where there are ramps, whereas AD M requires that handrails are provided on both sides of ramps.

In areas that are subject to potential spillages or contamination, the regulations require the use of slip-resistant floor finishes. Procedures should also be in place to avoid the likelihood of spillage in the first place and to clean up and guard areas where spillage does occur.

Regulation 19 covers escalators and moving walks and requires that they function safely, are equipped with the necessary safety devices and have easily identifiable and accessible emergency stop switches.

2.4 Construction Products Regulations 1994

The UK Construction Products Regulations (CPR) require construction products to be safe when incorporated into a building. All products supplied to a building that is subject to Building Regulations have to satisfy the requirements contained in these Regulations. Compliance can be most easily demonstrated by manufacturers CE marking their products, which verifies that they have been tested in accordance with the relevant harmonised European standards. Although CE marking is not mandatory in the UK, it is in most other EU countries, and many producers are already following this route. Since 1 January 1997 escalators and moving walks have had to have CE marking.

At the time of writing the CPR are under revision to clarify their implementation, following a consultation period. The main implication for the UK is that CE marking will become mandatory for construction products that fall under the scope of the Regulations before they can be marketed in the UK.

2.5 Construction (Design and Management) Regulations 2007

The Construction (Design and Management) Regulations 2007 (CDM) are designed to ensure that construction projects are safe to build, use and maintain, and that they deliver good value. They apply to non-domestic new buildings and refurbishment work, and

should be considered by anyone involved in the construction process, as well as the building's use and maintenance. The key aim is to integrate health and safety into the management of the project from conception to the end of the life of the building. Designers are required to 'avoid foreseeable risks to those involved in the construction and future use of the structure. In doing so, they should eliminate hazards (so far as is reasonably practicable, taking account of other design considerations) and reduce risk associated with those hazards which remain'.

2.6 Supply of Machinery (Safety) Regulations 2008

The Supply of Machinery (Safety) Regulations 2008, effective from January 2010, implement the Machinery Directive 98/37/EC with regard to health and safety when using machinery and are applicable to escalators and moving walks.

2.7 Provision and Use of Work Equipment Regulations 2008 (PUWER)

These Regulations concern the control or prevention of risks to people's health and safety that may be presented by the equipment that they use, including escalators and moving walks. They require that the equipment is:

- suitable for the intended use
- safe for use and maintained in a safe condition
- inspected to ensure that health and safety conditions are maintained
- operated only by suitably trained and qualified people
- accompanied by suitable safety measures: markings, warnings, emergency stop buttons

2.8 Standards and codes of practice

2.8.1 British and European standards

A number of British and European standards are applicable to the design, installation, maintenance and safety of steps, stairs, ramps, escalators and moving walks. Other standards cover relevant issues related to these elements such as slip resistance. The standards are not normally compulsory, but may be referred to within the Building Regulations and other regulations mentioned above, in which case they are deemed to satisfy the requirements of these regulations. Standards demonstrate proven good practice; however, other solutions may also comply with the regulations.

In some instances there are inconsistencies between standards and the regulations, as a result of developments taking place between publication dates. Unless otherwise stated, the most recent document should be used.

The most relevant standards for the subject matter of this book are the following:

BS 8300:2009 *Design of buildings and their approaches to meet the needs of disabled people. Code of practice*

BS 8300:2009 provides good practice guidance for the design of non-domestic buildings and their approaches. The document is comprehensive and covers features such as car parking provision and setting-down points, access routes to and around buildings, entrances, horizontal and vertical circulation, finishes and lighting within new buildings. It is the most recent guidance covering these areas, and generally should be followed in preference to other guidance.

Detailed guidance for steps, stairs and ramps is given in Section 5: *Access routes to and*

around buildings, Section 8: *Vertical circulation* and Section 9: *Surfaces and communication aids*. Escalators and moving walks are covered briefly in Section 8, and reference is made to BS EN 115-1:2008.

BS 5395-1:2010 *Stairs, ladders and walks. Code of practice for the design, construction and maintenance of straight stairs and winders*

This standard covers the principles and design of straight flights of stairs or flights with winders in different types of buildings, and gives good practice guidance on construction, materials and maintenance.

DD CEN/TS 15209:2008 *Tactile paving surface indicators produced from concrete, clay and stone*

This replaces BS 7997:2003 *Specification of products for tactile paving surface indicators.* It provides a guide to the application of external tactile paving as a system of communication of information for visually impaired people.

BS EN 115-1:2008 *Safety of escalators and moving walks. Construction and installation*

BS EN 115-1:2008 defines safety requirements for escalators and moving walks in order to safeguard people and objects against risks of accidents during installation, operation, maintenance and inspection work. It covers the detailed design and operation of escalators, as well as technical details for their operation and maintenance.

BS 5656-2:2004 *Escalator and moving walks. Safety rules for the construction and installation of escalators and moving walks. Code of practice for the selection, installation and location of new escalators and moving walks*

BS 5656-2:2004 gives recommendations for the location, selection and installation of new escalators and moving walks in new or existing buildings, for example at airports, exhibition centres, leisure facilities, shopping centres and department stores. It is applicable at the early stages of a project for architects, developers, building owners, building managers, building contractors, general and specialised engineers, consultants and other interested parties. It also covers access for disabled people with reference to the Disability Discrimination Act 1995.

BS 9999:2008 *Code of practice for fire safety in the design, management and use of buildings*

BS 9999:2008, replacing BS 5588, covers all aspects of fire safety and evacuation from buildings. Section 18 provides guidance on vertical means of escape including the provision and design of escape stairs, and Section 48 covers the evacuation of disabled people and the provisions that should be made.

2.8.2 Other British and European standards

There are many other standards relating to steps, stairs, ramps, escalators and moving walks covering their construction, materials, measurement of the characteristics of the finishes, cleaning and maintenance. A list of the main standards that are relevant is given in the References section.

2.8.3 Other standards and codes

There are other standards and codes for particular sectors/building types, including schools, hospitals, sports facilities and railway systems, which in some instances vary from the guidance given in the British and European standards. The differences are due either to the number of people using the premises and space constraints, for example large numbers of people using London Underground stations at one time, or to the type and ability of users, for example patients in hospital, or children in schools. Where there are differences this has been noted in the following guidance within boxes.

Schools

There are specific requirements for the design of stairs and ramps in schools, produced by the Department for Children, Schools and Families:

- Building Bulletin 102: *Designing for disabled children and children with special educational needs – Guidance for mainstream and special schools*, 2008
- Standard Specifications, Layouts and Dimensions (SSLD) 6: *Internal Stairways in Schools*, 2007

Healthcare buildings

The specific requirements for the design of all healthcare buildings are covered in a series of Health Building Notes and Health Technical Notes. The most relevant ones are:

- Health Building Note (HBN) 00-04: *Circulation and communication spaces* (Department of Health, 2007)
- Health Technical Memorandum (HTM) 08-02: *Lifts* (Department of Health, 2010)

Sports facilities

Sport England provides specific guidance on the design of sports facilities for use by disabled people, including steps, stairs, ramps and escalators: *Accessible Sports Facilities,* to be published in 2010.

Railway systems

The Department for Transport has produced a Code of Practice for the design of accessible stations under the Railways Act 1993 (as amended), and London Underground Limited (LUL) has specific requirements for its stations:

- *Accessible Train and Station Design for Disabled People: A Code of Practice* (Department for Transport, 2008). This guidance takes into account the European standards for accessible railway infrastructure, which were adopted by the UK on 1 July 2008
- *Station Planning Standards and Guidelines – Good Practice Guide* (London Underground Limited, 2007)

Design issues

3

Steps, stairs, ramps and escalators, together with lifts, are physical elements that enable people to change levels and circulate vertically, either externally or within a building. Any level change can create a physical barrier and safety hazard, particularly for people who have a mobility or visual impairment or breathing difficulties or who are encumbered with luggage or children and pushchairs. There are a number of issues that need to be considered and balanced when designing these elements.

3.1 Provision

Ideally, there should be a choice of means of vertical access as some means are not suitable for everyone, particularly wheelchair users, ambulant disabled people, people with visual impairments, people with assistance dogs and those with prams, buggies, shopping or baggage trolleys. The vertical and horizontal distance to be travelled and space availability/ constraints will also determine the means of access selected.

Stairs are a barrier to many disabled people but can also be difficult for people with young children and those encumbered with luggage

Wheelchair users cannot normally use any stepped access. Therefore, a ramp or lift is necessary for them, as well as beneficial to others with mobility or visual impairments or who are encumbered with children or baggage. However, some people, including ambulant disabled people and people who are unsteady on their feet, often prefer steps to a ramp. Significant changes in level necessitating a long, possibly zig-zag, ramp can be tiring and confusing.

Escalators are not suitable for wheelchair users, people with prams or people with assistance dogs, unless the dog can be carried. Other people find them difficult to use or do not like stepping onto something moving, whether they be escalators or moving walks. Therefore, where there are escalators, there must always be an alternative means of vertical access, ideally an accessible lift, but also stairs. Where there are moving walks, there should also be a parallel static walkway.

3.2 Location

In an external environment or building, the use, usability and safety of steps, stairs, ramps and escalators/moving walks will be affected by their location, and by their relationship with circulation routes and with each other.

3.3 Signage

Good, clear directional signage is essential to enable people, particularly those with mobility impairments, with children or encumbered with luggage or shopping, to move around an environment or building safely by the shortest and most appropriate route for them. This is particularly important where there is a choice of vertical access, which should be clearly indicated at all levels. There should also be signs warning of hazards and potential barriers, such as stairs or escalators, at either end of any route.

Signage also informs people where they are within a building, for example what floor level they are on. At each floor-level landing, there should be signs clearly indicating the floor level, usually attached to the wall. These may be tactile and in Braille as well as visual.

Clear floor-level signage at each landing assists people in finding their way in an unfamiliar building. Note that these stairs, in a hospital, have visually contrasting nosings and well-designed handrails that are fixed to the outside of the stairs, leaving the treads unobstructed for cleaning

Clear, well-positioned directional signage to the alternative lift access

Escalators and moving walks will also require mandatory safety signage in accordance with BS EN 115:2008 (see section 4.5.3).

The location and lighting of signs, the size and type of lettering and visual contrast should be designed in accordance with the good practice guidance given in BS 8300:2009 and the *Sign Design Guide*.

3.4 Capacity

Capacity is defined as the number of people that can move through a space (corridor, stairs, escalators, moving walks) per minute or per hour. It depends on the speed of movement, the density of people and the effective width of the space.

3.4.1 Steps and stairs

Because stairs impose a more disciplined, regular movement than a level corridor due to an even pace length determined by the going, higher densities than on the flat are possible. This is counteracted by a lower speed owing to either the effort of ascending or the care needed for descending, and the effective speed is very dependent on the slowest person. The Chartered Institute of Building Service

Engineers (CIBSE) Guide D, *Transportation systems in buildings*, states that the capacity on stairs is 83 per cent of that on the flat and is calculated using the equation:

$$C_s = 0.83(60vDW_s)$$

where:

- C_s is the capacity in persons/minute
- v is the average speed on the stairs in metres/second, normally between 0.9m/s for a young/middle-aged man and 0.5m/s for elderly people and family groups
- D is the average pedestrian density in persons/m^2, 0.6 persons/m^2 for free flow and 2.0 persons/m^2 for full flow
- W_s is the effective stair width

3.4.2 Escalators

Escalators are normally available in three widths: 600mm, 800mm and 1000mm. Theoretically, 600mm accommodates one person per step, 800mm accommodates one and a half (child) persons per step and 1000mm accommodates two persons per step. However, evidence from London Underground has shown that, in practice, densities are half these levels. In other words, 600mm accommodates one person per two steps, 800mm three persons every four steps and 1000mm one person every step. The equation given by CIBSE for calculating the capacity of an escalator is:

$$C_e = 60vks$$

where:

- C_e is the capacity in persons/minute
- v is the speed of the escalator
- k is the average density of people in persons/escalator step
- s is the number of escalator steps/minute, dependent on the depth of tread and escalator speed

See Table 9, section 4.5.4.

3.4.3 Moving walks

A moving walk is effectively a moving corridor as movement is not restricted by steps. The capacity calculation is the same as for corridors:

$$C_w = 60vDW_w$$

where:

- C_w is the capacity in persons/minute
- v is the speed of the moving walkway
- D is the density in persons/m^2, normally about 2 persons/m^2
- W_w is the width of the moving walkway

See Table 10, section 4.5.4.

3.5 Configuration

3.5.1 Steps and stairs

Straight flights of steps and stairs are easier and safer to negotiate than curved or dogleg flights with tapered steps. However, a series of long straight flights increases the distance that someone can fall without coming to a stop; they may also be intimidating from the top to people with a fear of heights.

A long straight series of flights may be intimidating from the top for those with a fear of heights and increases the potential distance that someone can fall down them

3.5.2 Ramps

Ramps may be straight, in a series of dogleg flights or curved.

3.5.3 Escalators

Escalators are traditionally straight, but spiral escalators are being developed.

3.6 Flight rise

3.6.1 Steps and stairs

People with mobility impairments or health problems (such as asthma or other breathing difficulties) may struggle with long flights of steps or stairs. However, providing shorter flights with more landings increases the number of transitions from landing to steps, which are a potential danger for people with visual impairments. Thus, it is important to achieve a balance between the two. Single steps are a significant trip hazard and should be avoided.

3.6.2 Ramps

The length of ramp that wheelchair users or ambulant disabled people can generally manage comfortably depends on the gradient: the steeper the gradient, the shorter the ramp should be. However, long shallow slopes or ramps may be very tiring, and several flights of ramps linked by half-landings may be confusing. Where a change in level would necessitate a very long ramp, a lift should be considered.

3.6.3 Escalators

The flight rise of escalators is limited only by mechanical technology.

3.7 Dimensions

The dimensions of steps, stairs, ramps, escalators and moving walks will affect their ease of use and safety, and the number of people that can move up and down them at any one time.

3.7.1 Steps and stairs

Width

The width of steps and stairs will depend on their estimated use, the capacity needed and whether they are escape stairs. For two people going in opposite directions to pass each other comfortably requires a minimum clear width of 1200mm.

Treads

Most people (particularly those with a visual impairment) benefit from a going that suits a natural cadence, especially when descending. Until very recently it was stated that, to achieve this, the sum of the going plus twice the riser should be 550–700mm. This is no longer supported, as stride length has increased as people have generally got taller, so it is not included in the updated BS 5395-1:2010.

Treads should be deep enough for the majority of people to get their whole foot on. Narrow treads increase the potential for slipping as less of the foot (50–60 per cent) is in contact with the tread, or people resort to turning their feet at an angle. A small increase in going can significantly reduce the likelihood of falls, and larger goings also allow people to pause mid-flight. However, steps with very large goings are effectively single steps, which may be a trip hazard (see **section 4.1.6**, *Single steps*, below).

Risers

A riser height of 150mm can be managed by most people; a little more than this is possible if the treads are deep and there are well-designed handrails. High risers increase the strain on the knee and/or hip joints of ambulant disabled people when descending stairs, and can be a trip hazard for people who wear leg braces or have stiffness in their knee or hip joints, particularly if there are projecting nosings. Steps with very shallow risers are similarly a potential trip hazard and should not be used: 100mm is the absolute minimum (see **section 4.1.5**).

Headroom

Clear headroom, without obstacles, such as signage, protruding into it, is essential for the safe movement of people. Where there is insufficient headroom, such as under staircases and escalators, guarding must be provided (see **section 3.15**).

Step profile

It is recommended that the treads of steps/stairs do not project beyond the riser as this can be a trip hazard, particularly for people with walking difficulties, who often place their feet up to the face of the riser; any overhang is likely to catch their toe as they lift their foot up. However, projecting a tread or a nosing over the riser can increase the depth of the tread.

3.7.2 Ramps

Width

The width of ramps will depend on their length and likely use. If two wheelchair users need to pass each other, a minimum width of 1800mm between upstands is required.

3.7.3 Escalators and moving walks

Width

The width of an escalator or moving walk will determine how many people can be carried and whether two people can stand side by side.

Treads and risers

As escalators are not primarily intended for people to walk up or down, and should not normally be used as static steps or stairs, there is less need for the going to fit a natural cadence. Treads should be as large as possible as many people will be standing on a step without moving. As a minimum (as for steps and stairs), they should be deep enough for most people to be able to get their whole foot on. The rise obviously varies, but what is important is that there is level access at the top and bottom for safe access and egress.

3.8 Gradient: ramps

Steeper gradients are more difficult for many people to negotiate, especially wheelchair users, ambulant disabled people and those pushing wheelchairs, prams, trolleys or other baggage. With gradients greater than 1:12 there may be a risk of wheelchair users tipping over backwards going up or falling out while descending; control and braking are also more difficult on steep gradients (see Table 6, **section 4.3.4**). Equally, shallow gradients over a long distance may be difficult for some people and tiring for many. Excessive cross-gradients may make it difficult for wheelchairs users, and other wheeled transport, to manoeuvre.

The gradient will also affect the required slip resistance for the surface finish (the steeper the gradient, the greater the slip resistance required – see **section 3.13.1**), which may restrict the choice of finish.

3.9 Angle of inclination: escalators and moving walks

The angle of inclination of escalators and moving walks affects their ease of use and their safety: the steeper the angle of inclination, the slower the speed should be (see section 4.5.6).

3.10 Speed: escalators and moving walks

Many people, particularly those with mobility or visual impairments, find it difficult to step, or are uneasy about stepping, onto something that is moving. The slower the speed, the easier it is for them to manage, but this has to be balanced with the number of people using the escalator or moving walkway and the flow of traffic (see section 4.5.7).

3.11 Landings

Landings/unrestricted space should be provided at the top and bottom of each flight of steps, stairs or ramps and at each end of escalators and moving walks, to enable people to safely and easily negotiate the change in level and access to and egress from the escalator or moving walk. They should also be provided at any change in direction of steps, stairs or ramps. Landings can also serve as resting places for people who are unable to ascend or descend a series of ramps or step/stair flights without a rest; where there is space, seating could be provided.

The size of the landing will depend on the dimensions of the steps, stairs, ramp, escalator or moving walkway and the traffic expected, and should be a clear space unobstructed by door swings or other obstacles.

3.12 Identification

Being able to identify changes in level or moving surfaces visually, using tactile indicators or by audible communication, is critical to their safe use and will minimise trips and falls. People with impaired vision risk tripping or losing their balance if there is no warning of a change in level or a moving surface; the risk is greatest at the top of a flight of steps, a ramp or an escalator.

3.12.1 Visual identification

All changes in level should be easy to identify visually at the top and bottom of each flight to warn people of a change in level. Similarly, the edge of each step within a flight of steps or stairs should be clearly identifiable visually when viewed from both the top and the bottom. This can be achieved by use of colour and tone to provide visual contrast with the addition of contrasting surface textures, if appropriate.

Visual contrast is assessed by comparing the light reflectance values (LRVs) of different surfaces. The LRV is a measure of the total quantity of visible light reflected by a surface at all wavelengths and directions when illuminated by a light source. The LRV scale

Colour providing visual contrast should be used to identify changes in level as at the bottom of these stairs and escalator; care must be taken that different finishes have similar frictional resistances

runs from 0 (all light totally absorbed) to 100 (all light reflected). Evidence-based research has indicated that an LRV of 30 or more will provide good contrast; an LRV of 20–30 may be adequate, particularly when the areas concerned are large, but below 20 the contrast is unlikely to be adequate. It is thought that small objects on a larger background need to have greater visual contrast. A variety of methods for measuring LRV are given in BS 8300:2009, Annex B.

3.12.2 Tactile indication

Tactile warning surfaces can be used at the top and bottom of each flight of steps or stairs, but care must be taken that they do not create an additional hazard. The key factor is the different frictional resistances of adjacent surfaces: sudden significant changes in frictional resistance can cause stumbling, trips or loss of balance. Any tactile warning must be placed sufficiently in advance of the steps to allow time for a person to stop, and must be sufficiently wide that it cannot be missed in a single stride.

These metal strips inserted into the stone floor provide a visual and tactile warning for the stairs. They are a sufficient distance from the top step, cover a wide enough area that they cannot be missed in a single stride, and will have a similar frictional resistance to the surrounding stone floor

AD M recommends only the use of a 'corduroy' tactile hazard warning surface on external steps.

3.12.3 Audible identification

Audible communication to warn people of hazards such as escalators or moving walks is extremely helpful to those with visual impairments.

3.13 Finishes

The finishes used on steps, stairs, ramps, escalators and moving walks will affect their safe and easy use, the risk of slipping and their visual appearance and identification.

3.13.1 Slip resistance

The slip resistance of a surface affects the traction between a foot or wheel on the surface. Floor finishes selected should provide sufficient traction to reduce the potential for slipping but not so much traction as to prevent easy movement, particularly for wheeled traffic. Very rough surfaces or materials with a deep pile (carpets or coir matting) are more difficult for wheeled traffic and require more effort.

The slip resistance of a surface depends on many factors:

- the roughness of the surface
- whether it is contaminated with liquid or dry substances: water and other contaminants are likely to significantly decrease the slip resistance. The more viscous the wet contaminant, or the finer the dry contaminant, the more the slip resistance is reduced. Dry contaminants, such as litter, may also be a trip hazard
- wearing characteristics and durability: the slip resistance of some surfaces decreases with wear and age as the surface wears

and roughness decreases, whereas the slip resistance of safety vinyls tends to increase with age and wear
- the texture/profile of the floor: although profiled and riven surfaces may appear to be more slip resistant, this is not often the case. It is the roughness of the highest surface of the profile that determines the slip resistance
- use of waxes, polishes and other coatings: these will alter the slip resistance of the surface, in most cases reducing it, unless they are specially formulated to be slip resisting (although this is effective only when the surface is dry)
- cleaning and maintenance: the frequency of maintenance and cleaning, the thoroughness, the method of cleaning and the cleaning substances used will affect the slip resistance and may also affect the roughness of the surface over time

Slip resistance can be measured as:

- coefficient of friction (CoF)
- slip resistance value (SRV) or pendulum test value (PTV), which is the coefficient of friction × 100
- roughness (see below)

A SRV of 36 or more in the wet on a level surface is considered to be a low slip potential. For external level surfaces, BS 8300:2009 recommends a wet SRV greater than 36 as suitable, or greater than 40 where a user is likely to be turning or pushing (a wheelchair, pram or trolley).

The most common method of measuring the slip resistance of a surface is using a pendulum tester, but several other methods are available, as described in *Assessing the Slip Resistance of Flooring* (HSE, 2007). Any data given should always state which test method has been used. Measuring the slip resistance of steps, stairs and nosings can be difficult as there may not be space for the pendulum tester to be used in accordance with BS 7976-2:2002. In this case, either the materials can be tested before installation using this method or the roughness of the surfaces can be measured *in situ* in accordance with BS 1134-1:1998 (see below). Slip resistance information supplied by manufacturers is for ex-factory materials; slip resistance can change significantly as a result of installation processes (grouting, burnishing, polishing), wear and tear, and inappropriate cleaning or maintenance.

Sudden changes in the frictional characteristics, for example as a result of different adjacent materials, can cause stumbling, trips or loss of balance, particularly for people with mobility or visual impairments. Therefore, adjacent surfaces, particularly at the top and bottom of changes in level, should have similar frictional resistances (see section 3.12.2). Care should be taken to check that apparently similar products do in fact have similar slip resistances, as they may differ significantly depending on their surface coating.

Detailed information on assessing slip resistance on wet and dry SRVs for common materials is given in BS 5395-1:2010.

3.13.2 Roughness

Roughness is the measure of the irregularities in a surface, which are often invisible to the naked eye. It directly affects slip resistance, particularly if the surface is contaminated with water or other liquids. One simple measurement of surface roughness is Rz, which is a measure of total surface roughness, calculated as the mean of several peak-to-valley measurements. It is measured in microns (μm) by a micro-roughness meter in accordance with BS 1134-1:1998 (Table 1).

Table 1 Surface roughness and potential for slip

Rz surface roughness (μm)	Potential for slip
<10	High
10–20	Moderate
>20	Low

Roughness values should never be used in isolation as a measure of slip resistance.

3.13.3 Contamination

Any contamination on surfaces will increase the risk of slipping. The most common contaminant is water, but other contaminants, such as other fluids, food, excrement, dirt, dust and debris, may also be present as a result of spillages, transfer from external areas, age/wear, cleaning processes or lack of cleaning. Anti-icing substances can be a particular problem as, although they prevent ice forming, they make the surface very slippery. Contamination should be avoided by regular cleaning and maintenance of the steps or stairs and any accidental contamination should be removed promptly.

Litter on steps is a trip and slip hazard. Note the lack of nosings and tactile warning surface at the foot of the steps

Surface roughness (see **section 3.13.2**) is a key factor in reducing the potential for slipping on a surface contaminated with liquid; generally, the more viscous the substance, the greater the surface roughness required to provide adequate slip resistance. Surfaces likely to be contaminated with water should have a roughness of greater than 10μm, preferably 20μm or more. More viscous contaminants are likely to necessitate a higher surface roughness.

Where stairs, steps, ramps or landings are likely to become wet, they should be designed to shed water and prevent ponding. If stairs, ramps, escalators or moving walks are near entrances where water and dirt could be carried onto them, adequate matting should be provided.

3.13.4 Wear resistance/abrasion resistance

The level of resistance required for stair finishes depends on the use of the area, the type and level of traffic and the service life required (Table 2).

Table 2 Wear resistance required in different locations

Location	Level of resistance required to:			
	Wear	**Indentation**	**Water**	**Chemicals**
Communal staircases in civil, public and commercial buildings	High	Medium	Variable	Low
Communal staircases in hospitals	High	Medium	Variable	Variable
School buildings	High	Medium	High	Low
Hotels	High	Medium	Variable	Low

3.13.5 Reflection

Shiny floor and wall surfaces may give rise to reflection and glare, which can cause discomfort and visual confusion. Changes in level and actual steps or ramps may be difficult to distinguish, particularly for visually impaired people. Shiny floor surfaces may also 'look' wet and slippery, even if this is not the case, and therefore may be a cause of anxiety for those with a fear of falling.

Bright ceiling lights reflected on the shiny surface of a ramp can cause glare and may be confusing

Glare from bright sunlight on this external metal ramp may be difficult or confusing, particularly for people with visual impairments

3.14 Handrails

Handrails are an important factor for everyone in relation to the safe use of steps, stairs, ramps, escalators and moving walks. Even if not used all the time, they may be grabbed in the event of a trip or fall. Handrails are particularly important for people with mobility or visual impairments. People with impaired mobility or balance may need the physical support of handrails, and wheelchair users may need them to pull themselves up, or steady themselves going down, a ramp. Disabled people may be weaker on one side, therefore

handrails on both sides are essential. Visually impaired people often rely on handrails to orientate themselves and determine when they have reached the top or bottom of a ramp or a flight of steps or stairs, or where there is a change of direction.

To be effective, handrails should:

- be strong enough, and suitably fixed, to provide physical support. As well as being needed on the steps or stairs, they may also be used at the top and bottom by people who need to steady themselves before ascending or descending
- be easy to reach
- be easy and comfortable to grip, including for people with limited manual dexterity: they should have a profile that allows the palm of the hand to be fully supported and the fingers to wrap around
- provide good forearm support for people who cannot grip: a flatter profile gives better forearm support
- be easily distinguishable, by having luminance and colour that create visual contrast against the background, without being highly reflective
- offer good tactile information to the user by being continuous around landings and extending horizontally beyond the top and bottom of flights of steps/stairs or ramps to indicate the change in level. Tactile markers can be used on handrails at the beginning and end of a flight, indicating floor level reached; this is particularly useful where the handrail continues along the wall of a lobby or corridor
- extend horizontally beyond the top and bottom of steps, stairs or a ramp to provide guidance of the change in level
- allow unobstructed passage of the hand along the rail, which should be supported centrally on the underside, and have sufficient clear space above the handrail and between the handrail and any adjacent wall
- be smooth but with adequate resistance to prevent excessive hand slippage
- be comfortable to use: they should not be too cold or hot to the touch. Metal handrails can get very cold in cool weather, and dark-coloured handrails may become very hot if exposed to direct sunlight as dark colours absorb heat whereas light colours will reflect it
- have ends that turn down or in towards a wall, to reduce the risk of clothing being caught on the ends of rails

Well-designed handrails can provide support and guidance at changes in level

3.15 Guarding

In relation to changes in level, guards and barriers are required to protect people from falling and, in non-domestic buildings, are required where there is a change in level greater than 380mm. Barriers or guarding may also be required to prevent people, particularly those with a visual impairment, inadvertently colliding with obstacles or walking into hazards, such as the underside of freestanding stairs or ramps or the moving parts of escalators or moving walks.

Barriers need to be high enough to provide adequate protection and prevent people being

able to fall over them. They should not be climbable nor have gaps in them large enough for a child to get through. Barriers should have a kerb or tapping rail at the bottom as guidance for visually impaired people using a stick.

These glazed barriers prevent people falling into the lower area or onto the ramp from the pavement. Note that the rail on top of the glazing is angled to prevent people getting too close to the glass and damaging it

These simple metal barriers prevent people walking into the soffit of the escalator and staircase or into the column

Guards and barriers are covered in AD K, in Section 4 of the Technical Handbook for non-domestic buildings (Scotland) and in Part H of the Building Regulations (Northern Ireland). Further guidance is given in BS 6180:1999 *Code of Practice for barriers in and around buildings*.

3.16 Lighting

Poor lighting can increase risk of trips, slips and mis-stepping on changes in level. All landings and changes in level should be well and evenly illuminated, particularly at the top and bottom and where there are any changes in direction. Strong, directional lighting can cast shadows, which may mask hazards; this can be avoided by increasing ambient lighting levels and not using directional spotlights. On the other hand, carefully positioned lighting can be used to highlight steps, nosings and other hazards. Good lighting can increase the feeling of security, and well-lit stairwells and lobbies may act as a 'beacon' and assist wayfinding in places such as car parks.

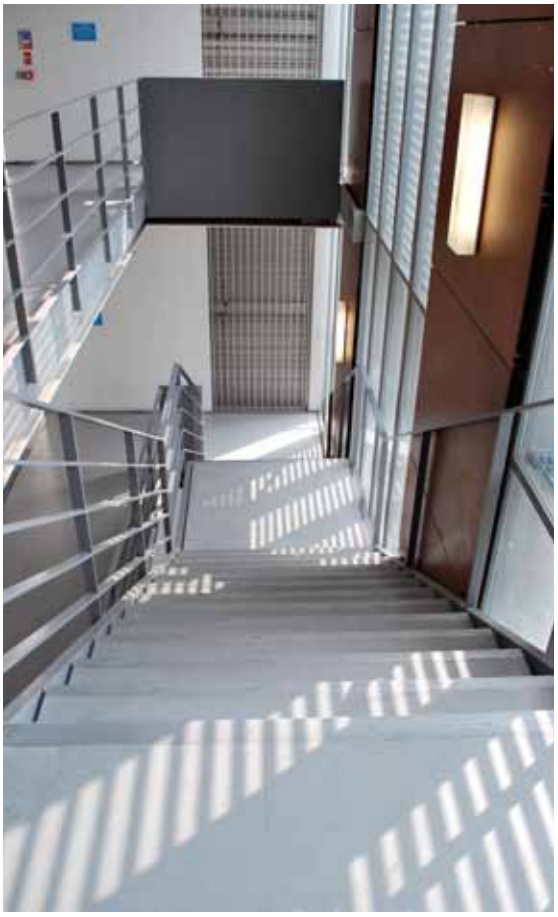
Poorly lit external steps: the edge of the three steps is not identifiable and it is only the handrails and the tactile corduroy surface that indicate the presence of steps

Well-lit stairs, with visually contrasting nosings, in a dark exhibition space. However, the handrail cannot be clearly identified

Windows and artificial lighting should be positioned so that they do not cause unwanted shadows, reflections or glare by shining directly into the eyes of the person using the stairs, ramps or escalators, or they should be shaded. Reflections can also be minimised by the use of non-reflective finishes on all surfaces.

It may be difficult for some people, particularly those with visual impairments, to adjust their eyes quickly to abrupt changes in lighting levels: all changes in lighting should be gradual.

The type of lighting will affect how accurately colours appear, which is important for some people with visual impairments. The Commission Internationale de l'Eclairage (CIE) colour-rendering index is the most widely used measure for this. It is based on the accuracy with which a set of test colours is reproduced by a lamp relative to how the same colours are reproduced by a standard light source, with a perfect agreement being 100.



Shadows caused by bright sunlight through the Venetian blinds obscure these stairs, which do not have visually contrasting nosings, and may confuse people with visual impairments

3.17 Acoustics

Hard surfaces reflect sound and cause reverberation, which will create a noisy environment. This may make it difficult for deaf people and people who are hard of hearing or have hearing loss to understand what is being said, and for visually impaired people to correctly interpret particular sounds. Reverberant noise can be reduced by applying soft, sound-absorbent finishes to the ceiling and undersides of staircases, ramps, escalators and moving walks.

Noise caused by impact or machinery may disturb occupants of adjacent rooms; if an adjacent room is required to be quiet, the stairs or escalators should be isolated from it, by planning, construction or insulation.

Acoustic design is covered in BS 8233:1999 *Sound insulation and noise reduction for buildings. Code of Practice*.

3.18 Ease of cleaning

Cleaning will have a significant effect on the safety and performance of steps, stairs, ramps, escalators and moving walks, particularly with regard to slip resistance and minimising slips, trips and falls. It can also affect durability, contamination, perception of colour and light reflectance values, as well as hygiene and appearance.

Ease of cleaning is affected by design and by finishes. Steps, stairs and ramps should be designed to be easily cleaned, particularly at the corners and edges, and surfaces should be free from obstructions such as fixings, where dirt and debris could get trapped. Generally, the smoother and less porous the surface, the easier it is to clean. However, textured surfaces, possibly required to give adequate slip resistance when wet, can be satisfactorily cleaned using the right equipment. The ease with which a surface can be cleaned is a function more of the nature of the contaminant than of the roughness of the surface.

Technical guidance and specification

4

4.1 Steps and stairs

Steps and stairs give rise to a significant number of accidents and injuries as a result of slips, trips and falls (see section 1.2). Eighty per cent of accidents are likely to occur when users are descending the stairs: going up, someone will usually only fall a few steps; coming down, they may fall an entire flight. Research has shown that older people are more prone to falling owing to deteriorating vision and balance, and their injuries tend to be serious and often involve fractures. A study examining the muscle strength of people aged between 70 and 75 years found that 50 per cent of women and 15 per cent of men could not go up a step of 300mm without holding onto a handrail. Research to date has mainly focused on stair falls in the home, and there are still gaps in the research relating to stair falls in non-domestic situations.

The factors that affect falls on stairs are:

- the dimensions of the treads and risers and their consistency
- profile
- visibility of the steps including position of the nosings
- surface finishes and slip resistance
- provision and detail of handrails
- lighting levels
- signage
- tactile warning surfaces
- human factors such as speed of movement, crowding, conflicting movement, age, mobility or visual impairment, encumbrance, distractions, drink, violence, panic

The risk of slipping is also affected by:

- type of footwear: soling material and cleating pattern
- environmental factors: rain, condensation, snow, ice
- changes in surfaces: adjacent surfaces with very different coefficients of friction

The design of steps and stairs has been controlled by Building Regulations since 1944. The regulations were introduced to contribute to safety in buildings by controlling the rise, going, pitch and headroom of stairways and by requiring adequate balustrades and handrails. Current regulations also include finishes and lighting requirements.

Design guidance on steps and stairs is also given in:

- BS 8300:2009
- BS 5395 Parts 1 and 2

These wide steps in this public square, without intermediate handrails, are also used as informal seating; double-sided handrails are provided at either end

Stairs are a major design feature of this university building atrium. Flights of stairs either side of the atrium give access to all levels of the building, whereas stairs in the centre of the atrium lead down to an area that could be used as a small stage or can be used as informal seating

The straight flights of stairs lead onto spacious landings with continuous handrails at the top of the glazed guarding, and the square-edged steps are clearly identified by inset strips on the edge of the treads and a dark, contrasting band on each riser in place of the nosing wrapped round onto the riser. However, it may be confusing to some visually impaired people, who may perceive it as the edge of the step. The guarding and handrails fixed on the outside of the strings means that the treads are free of fittings and will be easy to clean

The timber steps have deep treads and two handrails on the outer side only, allowing the inner steps to be integrated with the raised platforms in the middle of the area as informal seating

The steps are clearly defined by inset metal strips with silicon carbide tape between them on the treads and a rebate on the riser





These curved stairs are designed as a feature of this reception and exhibition building, displaying the versatility and beauty of the natural wood. The steps are clearly defined by the use of visually contrasting colours on the treads and risers, a visually contrasting strip on the edge of each tread and lighting at the base of each riser. The handrail is an integrated part of the curved solid timber balustrade and is designed to be comfortable to hold and to provide support

Specific guidance for particular building types is set out in the standards and codes given in Section 2.

The primary function of steps and stairs is to facilitate vertical access between different levels, and in many situations this is the only requirement. However, steps and stairs may also be used as an architectural feature, an aesthetic enhancement to an external space or a building, or for a secondary purpose, such as seating. In these cases following the specified guidance to the letter may not be appropriate as it may diminish the architectural or aesthetic effect or secondary use. For example, where there are wide steps leading up to the entrance of a building, multiple handrails across the width may reduce the quality and visual impact of the steps and reduce their usability for seating. There should therefore be a balance of form and function in situations where there are major aesthetic considerations.

4.1.1 Provision

Steps or stairs should always be provided in addition to ramps that have a rise greater than 300mm, as they are preferred by some ambulant disabled people. They should also be provided in addition to escalators and lifts, and may be required as a means of emergency escape.

External steps

Ideally, the landscape around a building and the entrance(s) to it should be designed to avoid the need for steps. However, where there are significant gradients, changes in levels may be unavoidable.

Where possible, external steps should be protected from the weather. If this is not possible, there should be adequate drainage for rainwater to prevent ponding and potential ice hazard, by providing slight cross-falls to gullies at the sides of the treads.

Steps adjacent to escalators in this shopping arcade give people the choice of access. Note that these escalators are covered by a canopy whereas the steps are open to the elements

The area around these steps has been designed and graded to provide a harmonious step-free environment

Internal stairs

The minimum number of stairways needed in a building will be determined by the occupancy and use of the building (single or multiple), horizontal travel distances and emergency escape requirements.

4.1.2 Location

Internal stairs

Internal stairways should not be located so that they are a continuation of the normal line of pedestrian travel. It is much safer if a person wishing to ascend or descend a staircase has to make a conscious 90° change of direction. Ideally, stairs should be accessed from a landing or lobby area that offers sufficient space for people to congregate without obstructing a circulation route.

4.1.3 Signage

There should be clear signage to stairways in a building, particularly those used for emergency escape. Where plans of external environments or buildings are provided as information, all steps and stairs should be clearly indicated so that people can choose the most appropriate route for them.

4.1.4 Configuration

Straight flights are recommended, as these are easier and safer to negotiate, with any change in direction made via a half- or quarter-landing rather than angled, tapered steps. Where there is a series of flights of steps or stairs, AD K requires that, when there are more than 36 risers, there is at least one change of direction by 30° or more.

Helical or spiral staircases or other tapered treads are generally not recommended, because they make it difficult to achieve the recommended dimensions, and they can be difficult for guide dogs to navigate; however,

Straight flights with half-landings at changes in direction are easier and safer to negotiate than tapered steps, and intermediate landings in straight flights enable people with mobility or breathing difficulties to rest if necessary

they may be acceptable in certain situations. Helical stairs provide different going sizes, including larger goings, which some people prefer, and they can meet the minimum recommended dimensions if the inner radius is large enough. Guidance on their design is given in BS 5395-2:1984. It should be noted that BS 5395-2:1984 currently allows smaller goings on tapered and helical steps than AD K.

Helical or spiral stairs should not generally be used as a means of escape as they may cause problems for assisted escape.

Curved and spiral staircases can be used only when replacing an existing facility.

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LUL requires that stairs should change direction by at least 30° after two successive flights unless a 4.0m landing is provided.

4.1.5 Dimensions

Width

The unobstructed surface width of steps and stairs should be at least 1200mm and the width between handrails 1000mm minimum. This minimum ensures that people can use both handrails, if necessary.

Schools

In school buildings the preferred clear width of stairs is 1600mm, which allows two adults to pass or three people to carry a wheelchair safely; a width of 1200mm is suitable only for little-used stairs.

Shopping centres

For shopping centres it is recommended that stairs are 2500mm wide, and divided into channels by a central handrail, which separates up and down movement.

Rail stations

The minimum clear width of steps and stairs on a main route should be 1600mm: additional width may be required to accommodate passenger flows.

London Underground Limited

LUL requires a minimum width of 2000mm between handrails for a one-way staircase and 2400mm for a two-way staircase, with 300mm added for each central or dividing handrail. The required width is calculated according to the predicted passenger flow. Stairs in a passageway must be the same width as the passageway.

Double central handrails on these wide stairs in a London Underground station enable users to have support on whichever side suits them best, help to direct the flow of people and provide guarding to the central column at the top of the stairs

Treads and risers

BS 8300:2009 recommends a going of 300–450mm, which will meet the AD M requirement for goings of 280–450mm deep, and risers 150–180mm high (Figure 1). The riser height may be increased in certain circumstances, for example where the steps are adjacent to an existing building; this must be justified in the Access Statement. The going and risers of steps in a flight, or series of flights, should be consistent.

Tapered risers, where steps go along a slope, should not be used as they are a trip hazard, particularly for people with visual impairments.

External steps with tapered risers to take account of a slope across the steps present a trip hazard and confusing tactile hazard warning. Note that the ribs of the corduroy tactile warning surface are at right angles to the steps: they should be parallel to the steps

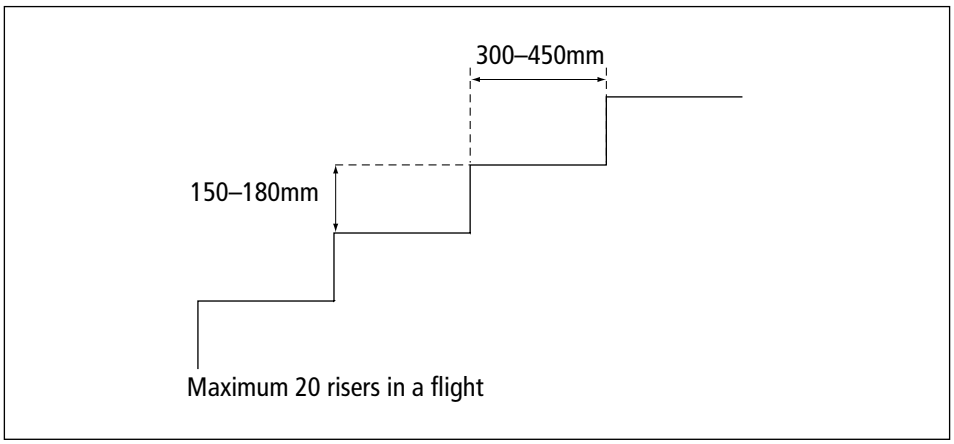


Figure 1 *Dimensions of steps and stairs recommended by BS 8300:2009*

A solution to steps across a slope is to divide them into separate flights with more even risers

Open risers

Open risers are not permitted under AD M. They may cause a feeling of insecurity as a result of being able to see through them to the floor/ground below, and light shining through them can cause visual confusion and disorientation, particularly for people with visual impairments. They may also cause people wearing leg braces or with limited knee and hip mobility to catch their toe and fall, and assistance dogs may refuse to use them. Solid risers assist people with visual impairments who use canes, and people who need to use sticks or crutches, to help maintain their balance.

Schools

The preferred rise is 150mm with a going of 300mm. (AD M states that for schools the rise should not exceed 170mm and the preferred going is 280mm.)

Healthcare buildings

In healthcare premises the recommended riser height is 150–170mm, and tread depth is 280mm minimum (and preferably 300mm).

London Underground Limited

Tread and riser dimensions recommended by LUL are shown in Table 3.

Table 3 Tread and riser dimensions

	Minimum (mm)	Maximum (mm)	Preferred (mm)
Tread	280	350	300
Riser	130	180	150
2 × riser + tread	550	700	600

© HSE

These stairs with open risers and perforated metal treads are not clearly visible and identifiable against a 'busy' background behind them

Opaque glass risers in this station have been effectively used to give a 'lighter' appearance to the stairs

Although the half-open risers of these station stairs may prevent people seeing through them easily, they may be confusing to people with visual impairments. The open part of the riser may appear to be a visually contrasting line, which could be mistaken for the nosing

Headroom

Part K of the Building Regulations requires clear headroom of 2000mm.

London Underground Limited

LUL recommends clear headroom of 3000mm. In new stations, if objects protrude into this space, the headroom must not be lower than 2400mm over a length of 2000mm maximum. For existing stations the headroom must not be lower than 2300mm under beams, soffits and Central Monitoring Service installations and 2100mm under signs, CCTV cameras and information displays.

Step profile

A simple step profile, preferably square (Figure 2), is generally recommended so that people who have difficulty lifting their foot do not risk catching their toes on the edge of the step. However, projecting the tread or the nosing over the riser can increase the depth of the tread: any projection should not be more than 25mm.

A sharp-edged profile will give good visual and tactile indication of the step, but may cause more severe injury in a fall, particularly if the nosing is of a hard material. A rounded profile is likely to cause less damage to a person who falls and will reflect light in different directions, increasing the definition of the step. However, it will slightly decrease the size of the step and will allow the foot to rotate and potentially slip.

The chamfer on these steps in a new public building is greater than 25° and, despite the smooth stone surface, may cause some people to catch their toes. Note that the nosing is only on the tread and is set back from the edge of the step, which may be confusing to people with visual impairments

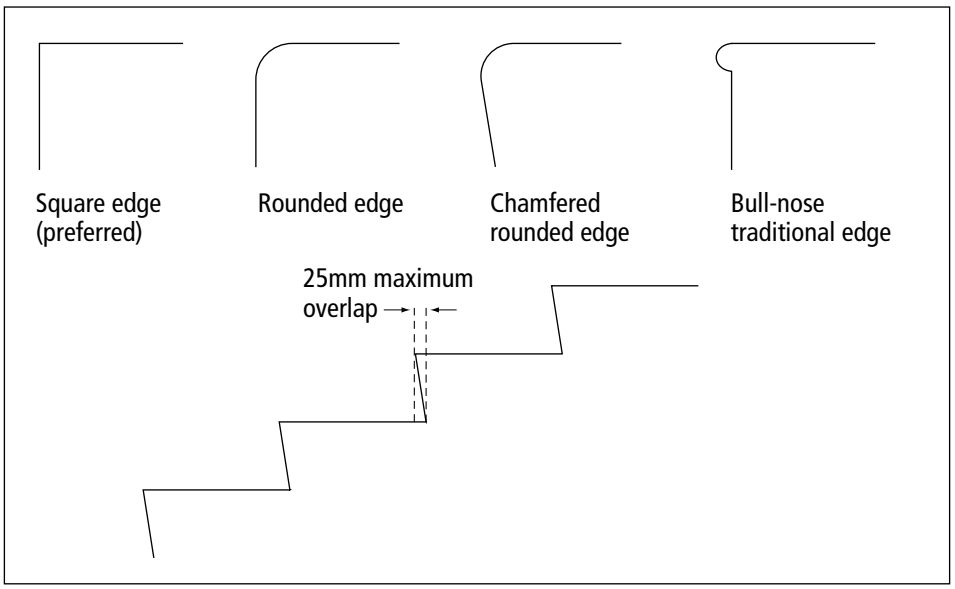


Figure 2 *Step profiles*

Rail stations

Step edges should be splayed or rounded with 6mm radius, without any projection.

London Underground Limited

LUL specifies that the risers on public stairways shall be undercut by 15–25mm.

4.1.6 Flight rise (number of steps)

BS 8300:2009 recommends that a flight between landings should not contain more than 20 risers (Figure 1). This is greater than the requirements in AD M, which specifies a maximum of 12 risers if the going is less than 350mm, and 18 risers if the going is greater than 350mm (Figure 2). The larger goings recommended in BS 8300:2009, which provide greater stability on each step, allow the number of risers to be increased if necessary.

The number of steps in successive flights should be uniform.

Healthcare buildings

The maximum recommended number of risers is 12–14, the higher figure being to take account of higher floor-to-floor heights, which are often 4.2m.

Shopping centres and assembly areas

AD K specifies that in shopping centres and assembly areas, flights with more than 16 steps should have intermediate landings for resting and pedestrian safety.

Sports facilities

Sport England recommends a maximum flight rise of 1800mm between landings, that is, 12 steps with risers of 150mm.

Rail stations

A minimum of three steps is recommended: below this a ramp should be installed.

London Underground Limited

LUL specifies a minimum of three risers and a maximum of 18, with 16 being the preferred number.

Single steps

Single steps are a significant trip hazard. They are discouraged by the Building Regulations for England and Wales and are prohibited by the Scottish Regulations and BS 8300:2009. If the change in level cannot be avoided, a ramp should be used rather than a single step.

Steps with very large goings are effectively single steps and can cause the same tripping issues.

A single tapered step with a small rise is a trip hazard and should be replaced with a regraded sloping surface

A large semicircular sloping matted surface provides a solution to a single step at the entrance to this office building

4.1.7 Landings

Level landings should be provided at the top and bottom of a flight of steps or stairs and between flights. The landing length should be at least 1200mm (1800mm preferred), or the clear width of the steps, whichever is greater, and the width should be the same as the step or stair width. The landing should be clear of any door swings or other obstructions. Where there are high traffic flows the length of the landing should be increased accordingly.

External steps

It is recommended that external landings, subject to weather and wetness, should have a cross-fall of 1:50 maximum, with appropriate drainage holes in edge upstands to help drain surface water.

Rail stations

European standards: the minimum length of landings should be 1600mm (the minimum clear width of steps or stairs).

London Underground Limited

In addition to landings, in some situations LUL requires there to be an additional space, 'run-off', beyond the landing to prevent undue congestion. LUL specifies the landing sizes shown in Table 4 for different locations.

Table 4 Landing sizes recommended by London Underground Limited

Location	Landing size	Minimum run-off
Street to top of stairs	2000mm	4m
Bottom of stairs	2000mm	4m
Intermediate landings	2000mm	
Staircase to ticket gateline	6–10m	
Run-offs should be increased when there are large passenger flows.		

4.1.8 Visual identification: nosings

All steps should have visually contrasting permanent nosings across the full width of each step on both the tread and the riser to define the edge of the step. This will help people with visual impairments appreciate the extent of the step and to identify the individual treads, both when ascending and when descending. BS 8300:2009 recommends that nosings should be 50–65mm deep on the tread and 30–55mm deep on the riser. AD M requires that the nosings extend 55mm on the treads and the risers. Nosings should be the same profile as the step edge (see section 4.1.5, *Step profile*) so that they are fully in contact with the steps; this will reduce the risk of any movement when a person's foot rotates on the edge of the nosing. They should be securely fixed and flush with the tread and riser. If of a durable material, nosings can also help to protect the edge of the stair from becoming worn.

These simple square-edged stairs in a hospital have well-contrasted nosings that meet the recommendations

There is currently a debate about whether nosings on the top and bottom step of each flight should be a different colour from the rest of the flight to differentiate them; however, there is no research-based evidence to suggest that this provides a safer environment.

Rail stations

Nosings should be a depth of 30–50mm on the risers and 55mm on the treads.

Slip resistance

To provide adequate slip resistance, nosings should have a wet SRV greater than 36 or, in the case of *in situ* nosings, where it is difficult to measure SRV, a surface roughness of 20μm minimum on the tread part of the nosing where it has a square edge. If the nosing is rounded, the slip-resistant finish should extend around the whole nosing.

The most common materials used for nosings are:

- silicon carbide
- synthetic rubber
- metal
- PVC
- aluminium and PVC inserts

Although these nosings on stairs in a concert hall do not fully comply with the recommendations, they do satisfactorily identify the edge of the step by the brass inlaid strips on the treads and the visually contrasting band on the riser

Silicon carbide tape can be an effective retrofit on internal stairs if it is properly installed. On concrete, the surface must be sealed, preferably with an epoxy-based fluid, before the tape is fixed.

Highly reflective materials should be avoided as glare and reflection can cause disorientation for people with visual impairments.

Adhesive coloured tapes and paint are not considered permanent; adhesive tapes may move or come unstuck and become a trip hazard. Paint is likely to need to be replaced frequently, particularly if the steps/stairs have heavy use, and may alter the slip resistance of the nosing, particularly if several layers have been applied.

These external corner stone steps are defined by a contrasting wide band on the tread and a narrow band below the step edge on the riser, with the top step defined by a contrasting riser. Note the corduroy surface at the top of the steps

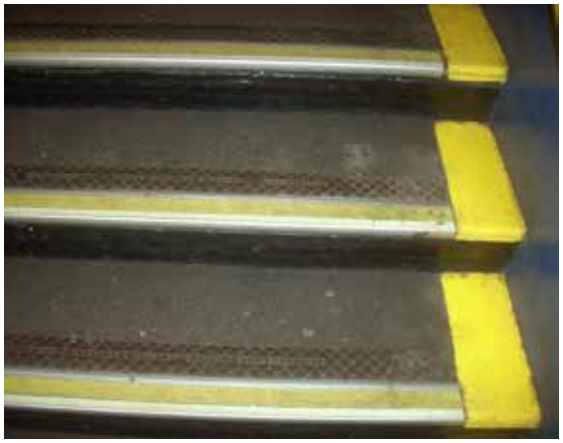
The inset strips on the treads of these stone steps provide some slip resistance and visual contrast with the light-coloured stone. The rebate at the back of the step is used to identify the steps in place of the nosing wrapping around the edge of the step onto the riser

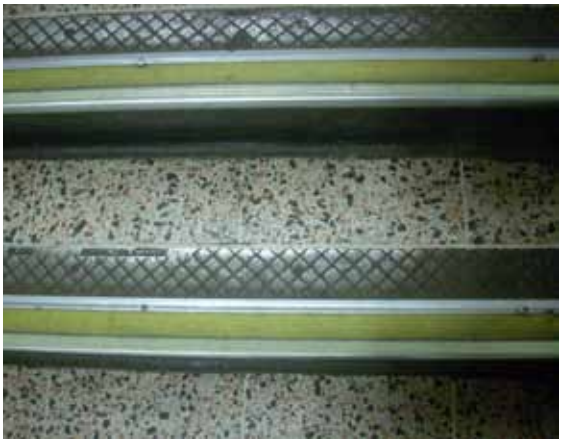
The yellow painted line has worn off these steps so that they are no longer clearly identifiable looking down. Note that the yellow line is set back from the edge of the step and does not wrap around on to the riser as recommended and, although there is a small rebate between the tread and the riser, the steps cannot be easily identified looking up from the bottom

Maintenance

Nosings are particularly vulnerable to wear and should be inspected regularly to ensure that they are not damaged or worn and are securely fixed.

The standard 50mm × 50mm nosings traditionally used throughout London Underground stations are made of gunmetal or bronze, both extremely hardwearing materials. A particular issue arises when a station is being refurbished and nosings that have greater visual contrast are required as it is difficult to justify the replacement of these hardwearing plates. Painting the nosings has been trialled but the paint quickly wears off with heavy use





Currently aluminium nosings which can be laid over and attached to the step edge are being trialled at two stations. These have a luminescent strip adjacent to the nosing edge and a slip resistant inset strip behind that. The edge of the nosing is feathered to the step. These nosings provide good visual contrast on both the treads and the risers but do provide a slight lip to the edge of the step. The slip-resistant strip would be more effective if it was on the edge of the tread and, where the nosing is rounded, it should wrap around the nosing onto the riser as this is where slips are most likely to occur. Where these nosings are on heavily used stairs, they have discoloured slightly and some dirt has adhered to the slip-resistant strip, but they still provide adequate contrast

4.1.9 Tactile and visual indication on landings

External steps

On external steps, a standard 'corduroy' hazard warning surface of raised ribs set parallel to the step nosings should be provided at the top and bottom of each flight (Figure 3). This acts as a warning to people with visual impairments of the presence of a trip hazard.

Where the approach is straight on in the same direction as the steps, the corduroy surface should be 800mm deep. It should extend across the full width of the steps plus 400mm each side at the top of a flight, and should start 400mm away from the nosing of the first step at the top and the bottom (Figure 4).

Unless there is access onto an intermediate landing from somewhere other than the steps, it is not advisable to use corduroy surfaces in these areas as they may cause confusion; continuous handrails are a better indicator across landings. Where there is access other than from the steps themselves onto an intermediate landing or on large intermediate landings where the handrails are not continuous, a corduroy warning surface should be used. Where there is sufficient space this should be 400mm deep, and 400mm from both the lower step of the upper flight and the upper step of the lower flight; tactile surfaces must be outside the line of the side access. If there is not sufficient space there should be a corduroy surface 400mm deep within the side access, provided that there is a continuous handrail opposite the side access.

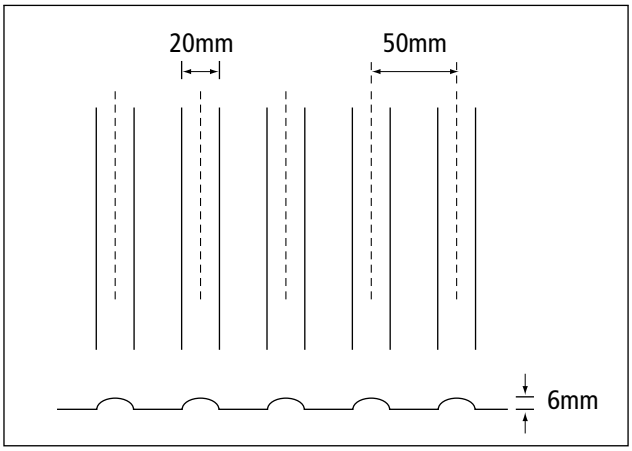


Figure 3 *Dimensions of corduroy surface*

The coefficient of friction of the corduroy surface must be similar to that of the surrounding surface(s) to reduce the potential for stumbling and falling. The corduroy surface should visually contrast with the colour of the surrounding area, but should not be red.

Guidance on tactile surfaces for external use is given in *Guidance of the Use of Tactile Paving Surfaces*, published by the Department for Transport, and DD CEN/TS 15209:2008 *Tactile paving surface indicators produced from concrete, clay and stone*.

The corduroy hazard warning surface in the same material as the surrounding surfaces on these external steps warns people with visual impairments that they are approaching stairs

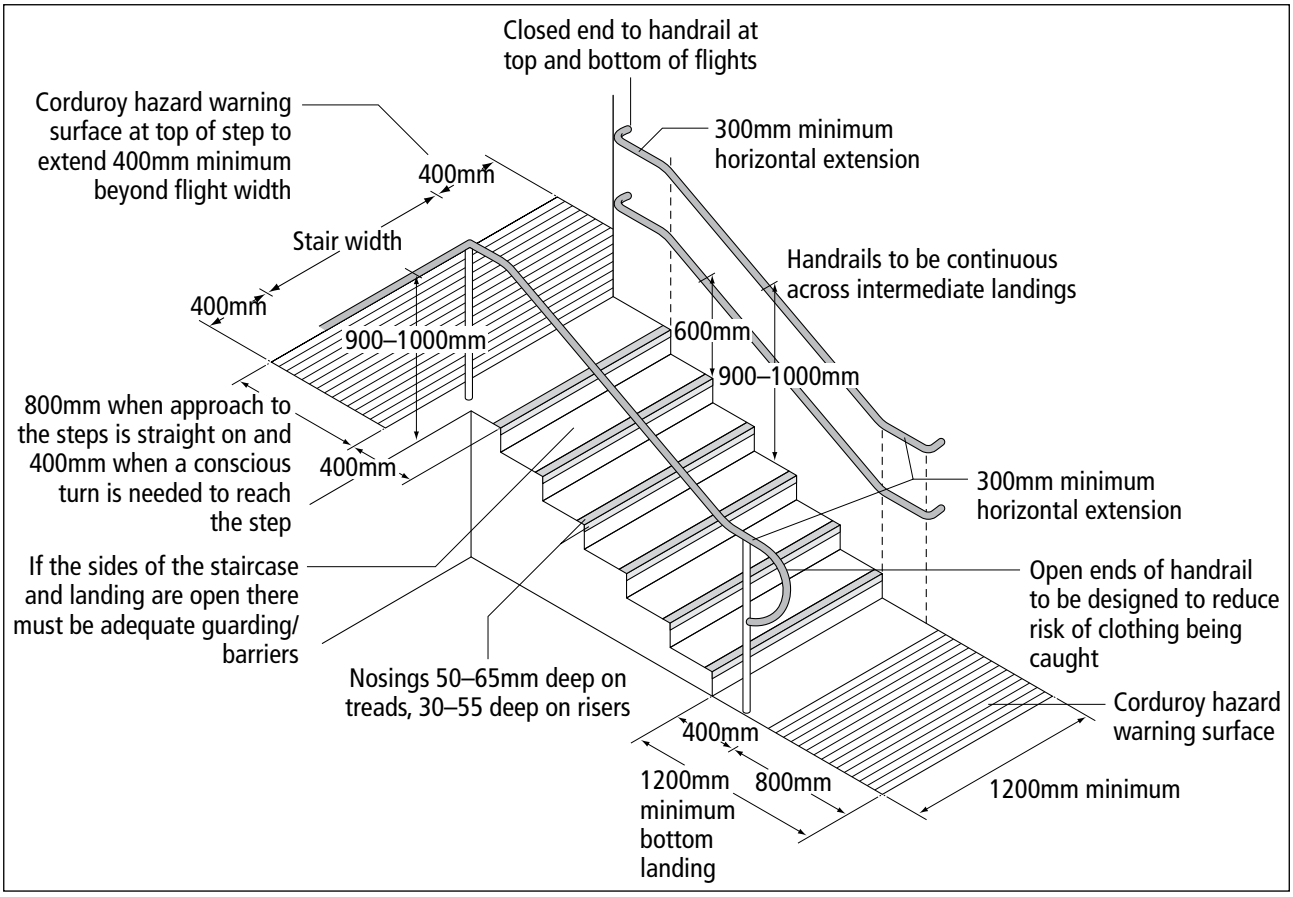


Figure 4 *Dimensions of corduroy hazard warning surface on external steps*

Internal stairs

For internal stairs a 'corduroy' hazard warning surface should generally **not** be used. AD M states that a tactile hazard warning surface is not reasonable on internal stairs as there is no standard recognised surface that is guaranteed not to constitute a hazard owing to different frictional resistance. However, where stairs are finished in a hard material, a corduroy finish, similar to that used in external environments, may be used as a hazard warning, provided that the frictional resistance is similar to that of the landing and stairs. This may be applicable in environments such as transport buildings, shopping centres, sports centres, museums, stadia and atria.

A change in floor surface texture or colour may be used at the top and bottom of flights of internal stairs and on landings, but care must be taken to ensure that the coefficients of friction of different adjacent floor surfaces are similar to avoid the risk of stumbling.

Rail stations

The European standard states that there should be a tactile band, 400mm deep, prior to the top and bottom steps across the width of the steps. The band should be integrated into and visually contrast with the floor surface, and should differ from the tactile surfaces used as a guide path.

It is recommended that standard corduroy hazard warning surface is used, and that it should be 800mm deep. Where practicable, it should extend 400mm beyond each side of the steps.

© HSE

Clearly visible and identifiable stairs, with handrails as recommended, in an underground station

© The Horniman Museum

A corduroy tactile warning surface may be used internally, as in this museum, provided it has the same frictional resistance as the surrounding surfaces. The horizontal extensions to the handrails also help to guide visually impaired people. Note the clear signage on the landing and the lower handrail

A visually contrasting surface at the top of the stairs helps to identify them, but care must be taken that the frictional resistance of different materials is similar

4.1.10 Finishes

The treads of steps and stairs should have a slip-resistant finish, when dry or wet, which is easy to clean and maintain. The risk of slipping is increased if the tread or nosing is finished in a smooth material, if the steps are wet or otherwise contaminated, or if the edge of the step is rounded.

The finishes on treads, risers and nosings should be consistent throughout a flight or series of flights of steps.

The slip resistance value (SRV) required on steps/stairs with a normal going is generally thought to be lower than on level surfaces because on steps/stairs the toe is the first part of the foot to make contact with the surface, not the heel, and the horizontal force between the foot and the step is lower. When the going is small, the overstep (the amount of the foot that is not on the step) is large, which increases the risk of slipping even with a high SRV. A going greater than 300mm significantly reduces the risk of a large overstep and the risk of slipping. It is recommended that the SRV for treads and nosings should be the same as that for level surfaces, that is, a wet SRV greater than 36 (see section 3.13.1). Particular care is

needed at the foot of a staircase: slips often occur here as the walking gait usually changes with an increase in stride length and a heel strike contact with the landing, both of which may increase the potential for slipping.

Where different materials are used for steps and landings, they should have similar coefficients of friction to avoid the risk of stumbling.

Healthcare buildings

HBN 00-04 recommends that there is a hazard warning zone, provided by a floor finish that contrasts visually with the surrounding floor finish, but with the same slip resistance, on each landing at the top of each flight. This zone should be at least 400mm from the nosing of the top step, a minimum of 800mm deep and 1200mm wide.

Internal stairs

Where stairs are adjacent to entrances and are likely to become wet, an appropriate flooring system such as firm matting (not coir) should be used to reduce the amount of contamination brought in from outside, and cleaning frequency should be increased.

Shiny polished surfaces should not be used as they may look wet, and therefore slippery, even if this is not the case, which may be a cause of anxiety for those with a fear of falling. They may also be slippery, particularly if they get wet. Shiny surfaces may also cause glare and reflection, which can be confusing; care must be taken to ensure that surfaces do not become shiny over time as a result of wear and cleaning.

Deep-pile carpet should not be used on stairs.

Heavily patterned finishes should not be used as they may disguise the edge of the treads, and cause confusion.

Glass and metal stairs are generally not recommended as they may generate impact noise, cause reflections if the surface is shiny, and cause confusion if it is possible to see through them.

However, carefully designed, they may be appropriate in certain situations.

A heavily patterned carpet and no nosings on these stairs in a theatre means that the steps are difficult to identify and present a potential mis-step and slip hazard

These glass stairs, lit from below, are likely to cause glare and be confusing to visually impaired people

4.1.11 Handrails

See section 4.4.

4.1.12 Guarding

The guidance in BS 8300:2009 is that where the sides of steps are open there should be guarding to a height of at least 900mm from the pitch line where the drop is more than 600mm. On landings with open sides the guarding should be a minimum of 1100mm high. Guarding should be in accordance with AD K, any other regulations and BS 6180:1999. In particular, it should not be climbable by children and should have no gaps or openings greater than 100mm.

It is recommended that handrails are independent of the guarding and are not used as the top rail at 1100mm high on landings (see section 4.4.2). It is also preferable to have guarding on steps to 1100mm to prevent falling over the handrail, with an independent handrail at 900–1000mm.

Where possible, areas below external stairs should be enclosed where the soffit is less than 2100mm from finished floor level. Where it is not enclosed, it should be protected by a guard rail at least 1000mm high with low-level cane detection in the form of an upstand or metal rail, a continuous raised flower bed that is more than 900mm high from ground level or a warning surface that is not intended to be walked on, such as cobbles, that extends sufficiently far out from the soffit. Care must be taken that this will not be a trip hazard. Such warning surfaces are not recommended where stairs and escalators are in the middle of pedestrian areas; in these situations the use of a physical barrier or a retail kiosk is advisable. Low kerbs or tapping rails should not be used without guard rails as they can be a trip hazard.

Glazed guarding on this staircase in a shop allows customers to see products on the floor below. Note the visually contrasting nosings, handrails and guarding supports

Railings protect people from inadvertently walking into the low soffit underneath these stairs in a station

© HSE

Artistic objects have been used to protect the area under the soffit of the stairs in this restaurant, but they may get displaced and could be a trip hazard

Healthcare buildings

Where steps/stairs are not adjacent to a wall, it is recommended that there is a barrier at least 100mm high above the level of the treads to prevent feet, crutches and sticks from accidentally slipping off the edge.

Where enclosure under the soffits of stairs is not possible, two rails at 1000mm and 200mm above floor level, or some other permanent barrier, should be provided.

4.1.13 Lighting

BS 8300:2009 recommends an illumination level on the surface of the treads and landings of at least 100 lux. The Society of Light and Lighting (SLL) recommends 150 lux. Any changes in lighting levels from the surrounding areas should be gradual.

Lamps should be positioned either such that light flows down the stairs so that the risers are in shadow, thus helping to define the steps, or such that they direct light towards the steps at approximately right angles in order to provide a clear distinction between each tread and riser. Care must be taken that lamps do not cause glare to users ascending or descending.

Internal stairs

Either windows should be positioned so that they do not cause glare or they should be shaded. Care should be taken that window mullions or blinds do not cast shadows across stairs or landings as these could be confusing for visually impaired people.

A window at the bottom of a staircase shaded with a blind to prevent glare to those descending the stairs

Ceiling or suspended lights over stairways may be difficult to access safely; wall-mounted lights may provide easier access, and will direct light at right angles to the stairs, helping to define the edges of the steps. Two-way switching for artificial lighting should be provided at the top and bottom of the flights at each floor.

Rail stations

The European standard states that, where artificial lighting is used, the level should be 40 lux above the ambient surrounding light levels and have a colder colour temperature.

It is recommended that lighting levels over steps and stairs are increased to 150–200 lux, with a smooth transition in lighting levels from the surrounding areas.

4.1.14 Acoustics

Internal stairs

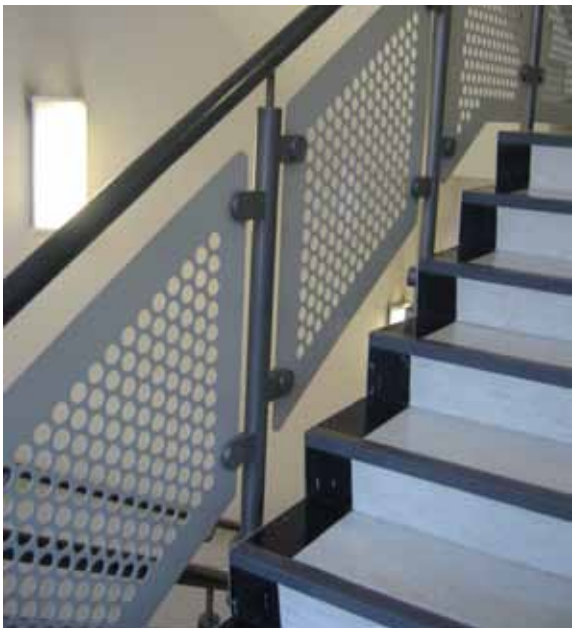
Stairways should preferably be located away from rooms that need to be quiet; if this is not possible, they should be isolated by construction/insulation and have sound-absorbent finishes to the ceilings and soffits.

Stairs of lightweight construction give rise to more impact noise than those of heavy construction, but soft finishes will reduce impact noise. Open treads tend to resonate disturbingly.

4.1.15 Ease of cleaning

Steps and stairs will be easier to clean if there is a clear flat surface with no obstructions such as fixings for handrail supports or guarding on the treads which can trap rubbish and dirt; where possible, guarding and handrails should be fixed to the outside of the outer string. Gaps between stairs and adjacent walls can trap rubbish and dirt: raised strings can be more easily sealed against the wall. The internal corners of steps and stairs are particularly difficult areas to clean; this can be made easier if they are coved or chamfered.

Steps with a gap at their edges will attract litter and dirt and be more difficult to clean



The combined handrails and guarding to these stairs is fixed to the outside of the outer edge of the stairs, leaving the tread free of all obstructions and easy to clean. The dark band at the edge of the stairs helps to visually define their width

4.2 Stairs that are used as means of escape

Means of vertical escape for disabled people may comprise a combination of structural provisions (stairs and associated refuge areas, ramps, lift) and management procedures (assisted escape). A strategy should be designed to enable a flexible response to different situations. A personal emergency evacuation plan (PEEP) should be produced for each wheelchair user who uses a building regularly.

Stair design can have an effect on the speed of evacuation; ambulant disabled people may ascend and/or descend stairs more slowly, and people with a fear of falling are likely to descend more slowly. Carrying a wheelchair user up stairs is harder than going down, and this will affect the time needed to evacuate any floors below ground level. Staff need to be trained in disability awareness and the use of carry-down procedures. The number of staff on duty needs to reflect the usage of the premises.

The provision, design and construction of stairs that are used as a vertical means of escape from a building are covered in AD B and BS 9999:2008 and these documents should be referred to for detailed guidance.

4.2.1 Provision

The number of escape stairs needed in a building is determined by:

- the horizontal escape routes
- the occupancy of the building: whether independent stairs are required in mixed occupancy buildings
- the number of people to be evacuated from each floor and width of the stairs
- whether the escape stairs have protected lobbies or a smoke control system, or the building has a sprinkler system
- in larger buildings, whether escape stairs may also need to be used for firefighting

Escape stairs can be external to the building provided that there is at least one internal escape stair from every part of each storey of the building and they meet the recommendations in BS 9999:2008.

A single escape stair may be used in a building in which no storey is more than 11m above ground level or from a basement, provided other conditions on horizontal travel distance and number of occupants are met. It may be external in certain circumstances.

If there is only one escape stair from the upper part of the building, it must not extend into the basement; there must be a separate protected stairway. A single escape stairway can extend into the basement if it is protected by a smoke control system and measures are taken to ensure that users are aware that they have reached final exit level. If there is more than one escape stair from an upper storey, only one of the stairs needs to terminate at ground level. Other stairs can extend into the basement provided that there is a ventilated protected lobby, or a ventilated and protected corridor between the stair(s) and accommodation at each basement level.

All internal escape stairs must be protected within a fire-resisting enclosure and should lead directly to a final exit, or to a protected passageway to a final exit. A protected lobby may also be required in certain circumstances.

4.2.2 Signage

All escape stairs and refuges must be clearly signed, as specified in current British Standards.

4.2.3 Configuration

Helical and spiral stairs should not be used as the only means of escape without additional compensating features, given in BS 9999:2008.

4.2.4 Dimensions

The width of escape stairs will be determined by the number of floors served, the risk profile, whether there will be simultaneous or phased evacuation and the estimated flow rate (Table 5). The width is measured as the clear width between walls or balustrades at the narrowest point up to 1500mm above the pitch line. For stairs where the vertical extent is greater than 30m, either the width should not exceed 1400mm, or it should be wide enough to accommodate 1000mm of clear space either side of a central handrail.

4.2.5 Handrails

See section 4.4.

For staircases that are used as a means of escape, consideration should be given to finishing the handrails with photoluminescent paint so that they are visible in all lighting conditions, including situations in which there is a loss of power.

4.2.6 Refuges

Refuges are relatively safe, protected places that should be provided in conjunction with each escape stairway. In an emergency situation, they act as temporarily safe spaces that can be used by people who are unable (or find it more difficult) to use stairs independently while they wait for assistance.

Table 5 Minimum width of escape stairs determined by occupancy characteristics

Occupancy characteristics	Width of stair for downward travel (mm)	Width of stair for upward travel (mm)
A (occupants who are awake and familiar with the building – offices, industrial premises)	1000	1200
B (occupants who are awake but unfamiliar with the building – shops, exhibition centres, museums, leisure centres)		
B (except assembly)	1000	1200
B (assembly only)	1100	1200
C (buildings where occupants may be asleep – hotels)	1000	1200

They must be at least 1400mm × 900mm and can either be within a protected stair lobby, or in an adjacent corridor provided that the width of the escape route is not reduced, or can be an adjacent protected room. Refuge areas must be clearly signed.

Refuges must have an emergency two-way communication system to a central point from where the evacuation of the building will be managed, so that those waiting can notify the management of their presence in the refuge and be kept informed of the situation for their safe evacuation. Communication systems must be usable and comprehensible by people most likely to use them, including those with sensory impairments.

4.3 Ramps

Ramps, defined as a gradient of more than 1:20, connect different levels and can provide an alternative means of access to steps and stairs for wheelchair users in situations where there is no accessible lift. They are also useful for others, such as parents with pushchairs or shoppers with trolleys. They may also be preferred to steps and stairs by some ambulant disabled people who have difficulty lifting their feet up and people with visual impairments. They need to be designed and detailed with care if they are to have real practical value. However, many disabled people who are not wheelchair users, and some older people, find ramps, particularly long ones, inconvenient or difficult, and prefer to use steps.

This wide, long, ramp provides the main access to a bridge and is used by most people in preference to the steps

There is a relationship between the length of a ramp and the gradient that people can manage; the longer the ramp the less severe the gradient that is feasible. Where a lengthy ramp is necessary, there should be frequent landings, possibly with seating, to allow people to rest. In existing buildings where an extreme level change would require a long, circuitous ramp or where space is limited, a short-rise lift may be appropriate either as an alternative or in addition to a ramp.

The gradient of the ramp will also affect the slip resistance required: the steeper the gradient, the greater the slip resistance needed (see section 4.3.9).

4.3.1 Provision

Where any route has a gradient steeper than 1:20, it should be designed as a ramp.

A slope or ramp should always be used where a change in level is less than 300mm, to avoid the need for a single step. Where the rise of the ramp is greater than 300mm, there should always be steps/stairs in close proximity, and if the total rise is greater than 2m ramps should be replaced by an alternative means of step-free access, such as a lift.

Some wheelchair users may not be able to use a ramp unaided, particularly if it is steep. Where possible, assistance should be available, with a call bell provided at the bottom (or top) of the ramp.

External ramps

Where possible, the main pedestrian route to the accessible entrance of a building, and other access routes across the site, should be designed to eliminate the need for ramps by manipulating the relative levels.

The single step at this recessed entrance has been replaced by a slope within the recess

A ramp to an alternative entrance starting from the foot of the steps provides a clear alternative to the steps to the café

A discreet ramp with a simple glazed balustrade matching the façade of this new office building and curving round the circular entrance door provides an alternative access to the two steps on the other side. At night the presence of the ramp is highlighted by lights set into the pavement

Integrating steps and slopes, as in this pedestrian area, has urban and practical advantages, but does create tapered steps, which can be a potential hazard for visually impaired people. The potential risk can be mitigated by providing a direct flight of steps with even risers and either handrails on both sides or a double-sided handrail, as seen to the left, visually contrasting nosings to the steps, corduroy hazard warning surfaces at the top and bottom of the regular steps and other tactile guiding surfaces at the top and bottom of the steps interrupted by the slope. Alternatively, planting could be used either side of the ramps to replace the tapered steps. The 'ramps' have a gradient of 1:21 and therefore do not need handrails. There have been no reported problems with these slopes and steps

Internal ramps

Internal ramps should, as far as possible, be avoided on main circulation routes, but this may not be possible in existing buildings (see **section 4.7**).

Healthcare buildings

Ramps are not considered appropriate for any significant changes in internal levels.

Rail stations

A ramp should not be the only approach to a station unless the change in level is 200mm or less, when a ramp may be acceptable to avoid the need for a single step.

Where a ramp is used for changes in level greater than 200mm, steps/stairs should be nearby.

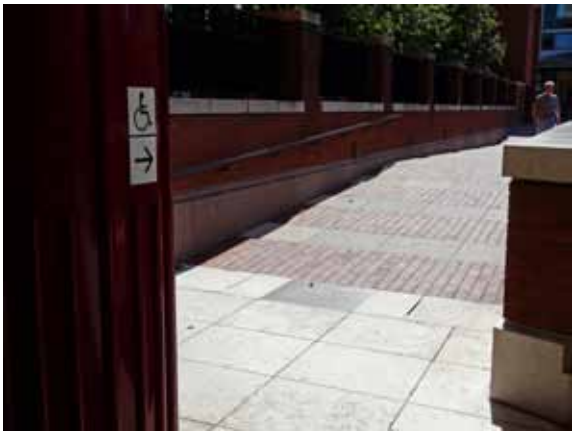
London Underground Limited

LUL requires that rises up to 500mm are ramped for all passengers.

A ramp alongside a short flight of stairs provides a choice of access in this museum. Note that the shiny floor surface is causing some reflections, which could cause confusion

4.3.2 Signage

Where a ramp is an alternative to steps and it is not readily apparent, its existence and location should be clearly indicated in text and with the international symbol for access.



Simple, clear signage with good visual contrast directing wheelchair users to a ramp. However, the ramp with its alternating brick and paved finish could be confusing to people with visual impairments, and to meet the recommendations it should have a central handrail

4.3.3 Configuration

Ramps can be straight, in a series of dogleg flights or curved.

An external dogleg ramp with two flights and a half-landing provides step-free access to this municipal building

The curved, shallow ramp around the internal perimeter is the major feature of the dome of this building and provides access to the top for everyone

The curved ramp around this exhibition space with glazed balustrades gives visitors a changing view of the exhibition below as they descend or ascend

A curved ramp around the perimeter of this landmark office building providing access to all floors is a design feature of the building. Lifts and stairs are also available

4.3.4 Gradient

BS 8300:2009 states that a ramped approach should have the lowest practical gradient within the range 1:20 to 1:12. The recommended permissible gradient depends on the going of a flight and the maximum rise (Table 6).

However, it should be noted that a route with a gradient of 1:20 over a significant distance can still be a potential barrier. A slightly steeper gradient of 1:10 is acceptable over very short distances if there is no alternative, for example a ramp covering a distance of 600mm when refitting existing buildings. Gradients steeper than 1:10 not only are physically difficult to manage but may cause a wheelchair to overbalance, and it is difficult to find a finish with adequate slip resistance (see section 4.3.9).

Table 6 Permissible gradients

Going of a flight (m)	Maximum gradient	Maximum rise (mm)
10	1:20	500
9	1:19	473
8	1:18	444
7	1:17	411
6	1:16	375
5	1:15	333
4	1:14	285
3	1:13	230
Not exceeding 2m	1:12	166

Rail stations

Ramps should slope at a consistent angle, preferably not more than 1:20. In existing stations, if a ramp steeper than 1:12 is necessary, it should not be longer than 3m.

London Underground Limited

Floors at a slope between 1:40 and 1:20 should be avoided.

4.3.5 Dimensions

Width

Ramps should have a clear surface width, between walls or upstands, of at least 1500mm (Figures 5 and 6). A width of 1800mm is the minimum required for two wheelchairs users to pass each other.

Where the width between the handrails of a ramp exceeds 2500mm, the ramp should be divided into two or more channels with a width between handrails of 1000mm minimum and 2000mm maximum. At least one channel should have a clear surface width of 1500mm.

A double central handrail on this wide ramp provides a choice of side for support and helps to avoid a clash of hands

Schools

In schools where there are many wheelchair users, wider ramps should be considered.

Sports facilities

Sport England recommends that at facilities where sports wheelchairs are likely to be used ramps should have a clear width of 2000mm minimum and that ramps in 'Sportschair Zones' of a sports centre should be a minimum of 1300mm wide.

Rail stations

In larger stations a minimum width of 2000mm between handrails is recommended, and for smaller stations with a total annual footfall of less than 250,000 the width can be reduced to 1350mm minimum.

Ramps over 4000mm wide should have a central handrail, preferably with double rails to avoid hand clashes.

London Underground Limited

LUL requires the width of a ramp to be calculated in the same way as that for a passageway if the gradient is 1:20, using the equations:

$$\text{Two-way passage width} = \frac{[\text{average peak minute flow} = (2 \times 0.3)]\ \text{m}}{40}$$

$$\text{One-way passage width} = \frac{[\text{average peak minute flow} = (2 \times 0.3)]\ \text{m}}{50}$$

Where the gradient is steeper, a 10 per cent reduction in the flow rate should be assumed.

Ramps should be a minimum width of 1200mm between handrails and, if greater than 2.4m wide, must have an intermediate handrail.

Headroom

Part K1 of the Building Regulations requires a clear headroom of 2000mm minimum.

4.3.6 Flight length and rise

No flight of a ramp should be greater than 10m, or rise more than 500mm. The maximum rise for a series of ramps is 2000mm. With a rise greater than this, an alternative means of step-free access, such as a lift, should be provided.

Rail stations

A ramp flight should not be more than 6m in length between level landings, or 3m if the gradient is 1:12 or greater. Ramps, including landings, over 50m in length in existing buildings should be subject to consultation with local people.

London Underground Limited

LUL specifies a maximum flight rise of 500mm in public areas. A change in direction of at least 30°, or another means of arresting uncontrolled descent, is required at every second landing.

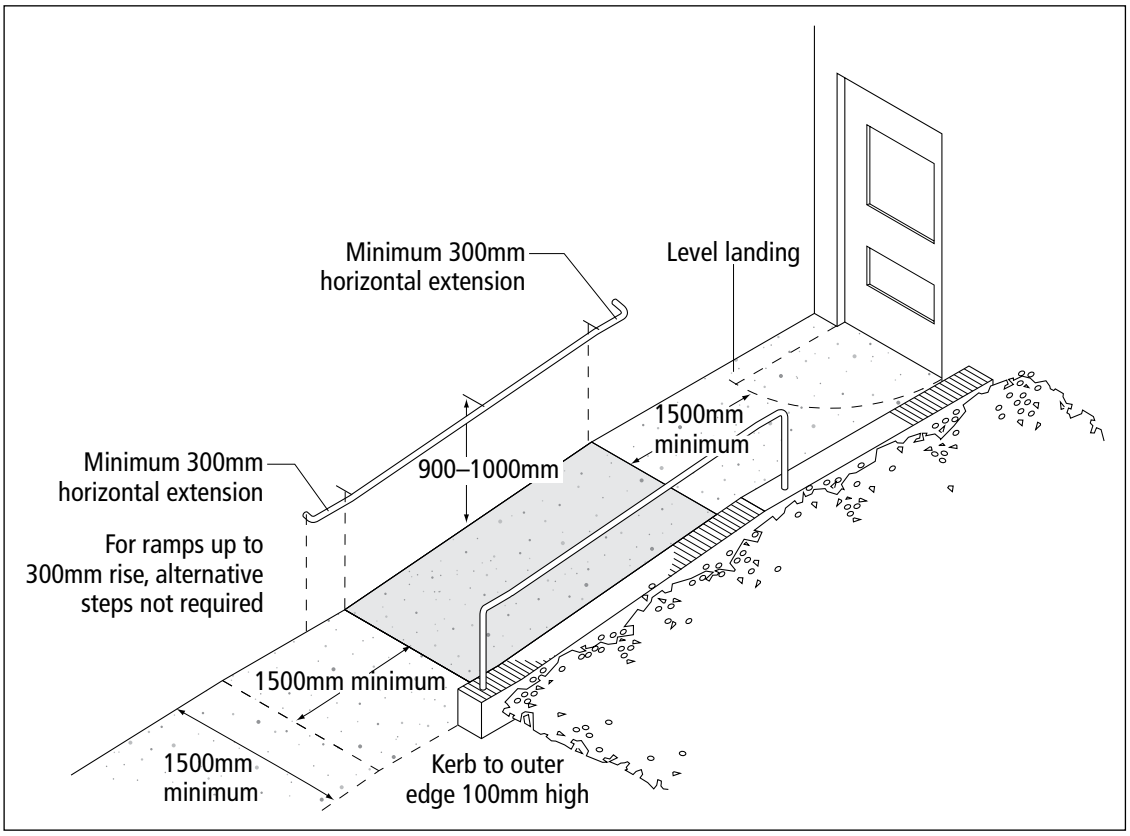


Figure 5 *BS 8300:2009 dimensions for a single ramp*

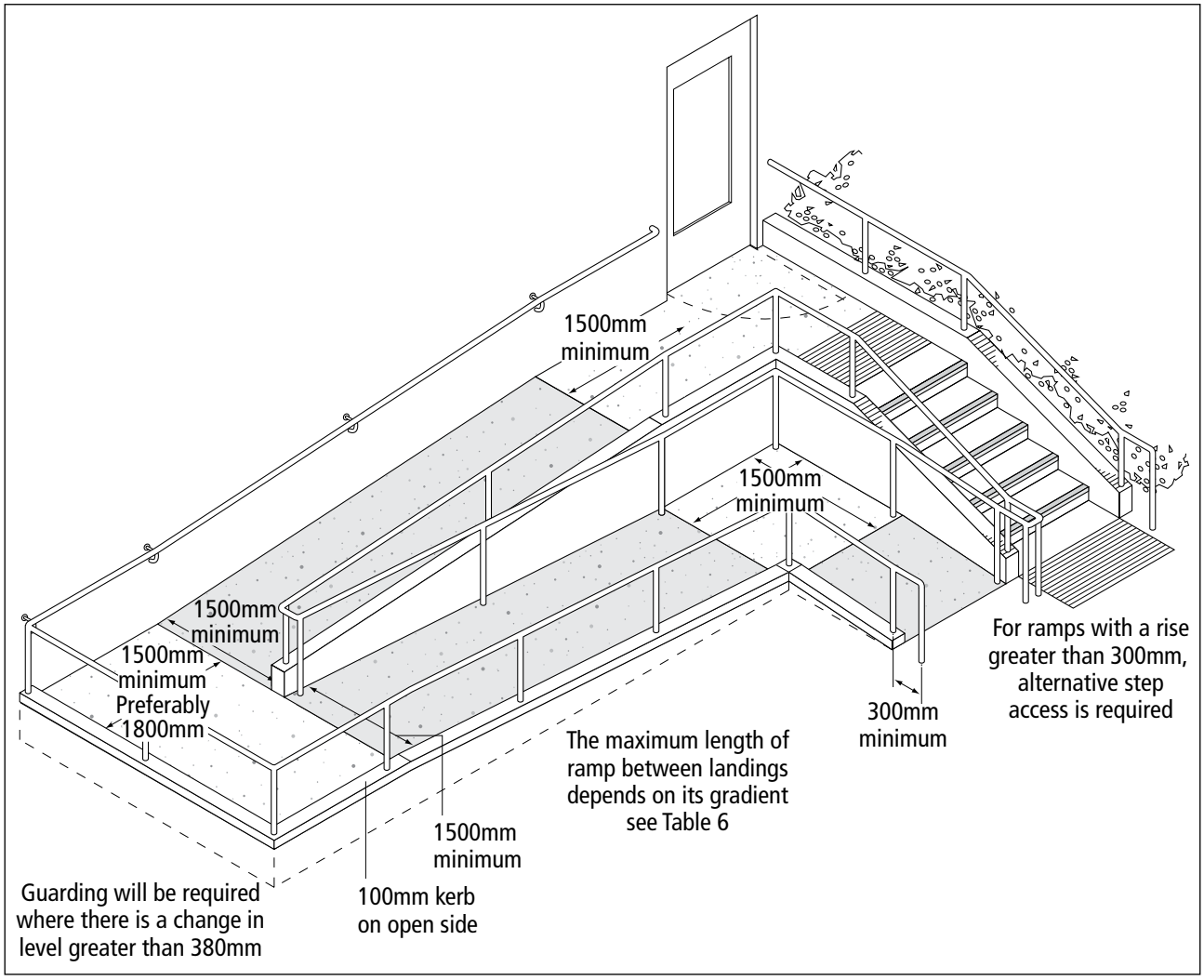


Figure 6 *BS 8300:2009 dimensions for successive ramps*

4.3.7 Landings

BS 8300:2009 recommends that landings should be at least 1500mm long, clear of any obstruction such as door swings, and the full width of the ramp (Figures 5 and 6). AD M requires level landings, clear of any door swings or other obstructions, at the head and the foot of a ramp at least 1200mm long.

If more than one flight is needed, there must be landings between the flights at least 1500mm long, and the full width of the ramp (Figure 6). If the intermediate landing involves a quarter- or half-turn, or a wheelchair user cannot see from one end of the ramp to the other, the width of the landing should preferably be 1800mm to allow wheelchairs to pass each other.

London Underground Limited

Top, bottom and intermediate landings shall have a length at least equal to the widest width of the ramp between the handrails and be not less than 2000mm.

The transition between the landing and the ramp should be sufficiently rounded to ensure that the foot supports on a wheelchair do not get caught.

External ramps

External landings should have a crossfall to facilitate surface water drainage: BS 8300:2009 recommends 1:50 maximum, whereas AD M gives a maximum crossfall of 1:40.

4.3.8 Identification

The surface of a ramp should contrast visually with that of the landings and the edge upstand.

A short ramp, replacing a single step, with a finish the same as the surrounding floor is not identifiable and is a potential trip hazard. Also note that the frictional resistance of the carpeted ramp and corridor is significantly different from that of the vinyl floor in the lobby beyond, also creating a slip or trip hazard

Identifying a ramp by visually contrasting lines is not ideal as these may be confusing to people with visual impairments who could interpret them as steps

A ramp clearly identified by the visually contrasting finishes. Note that there is only a handrail on one side of this wide ramp, and no central handrail

A surface with a different texture from the surrounding floor area may be provided at the top and bottom of a flight, but care must be taken that the frictional resistances of adjacent materials are similar to minimise the risk of stumbling.

Corduroy tactile surfaces must **not** be used at the top and bottom of a ramp, as these are used for external steps and therefore might cause confusion.

The prefabricated removable ramp to this café, with steps at the other end, is identifiable by the visually contrasting finishes and handrails

© Paul Highman

Contrasting finishes with similar frictional resistances distinguish the series of ramps and landings from the surrounding floor area in this museum. However, to fully meet the recommendations the ramp should have a central handrail

This ramp designed around steps and a landing to another room is an alternative access to the platform in this conference room. However, the stripes could be confusing to people with visual impairments and the frictional resistances of the wood floor and carpeted ramp are likely to be significantly different, which could be a potential trip hazard

4.3.9 Finishes

The surface of ramps should be slip resistant, even when wet, and should be durable and easy to maintain. It should have a matt surface to minimise reflections, which could be confusing, and so that it does not look wet, and therefore potentially slippery, when it is actually dry. Any applied surface should be firmly fixed.

Patterning which simulates steps, such as stripes or applied or inserted slip-resistant strips, should be avoided as this may cause confusion to people with visual impairments.

Slip resistance

Ramps require higher slip resistance than a level surface, as the lateral component of the force in contact with the surface increases as the gradient increases. To estimate the coefficient of friction required on a slope, the tangent of the angle of the slope should be added to the requirement for the level (Figure 7).

Another way of achieving the same result is to add the gradient expressed as a percentage to

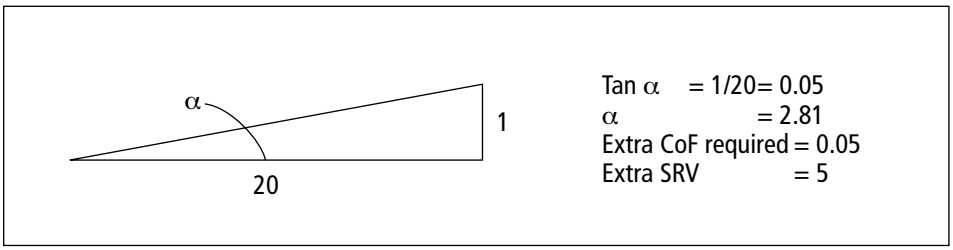


Figure 7 *Coefficient of resistance required on a slope*

the SRV for an equivalent level surface: 1:20 is a gradient of 5 per cent (Table 7). Therefore, the additional slip resistance required, compared with an equivalent level surface, increases with the steepness of the ramp.

Given that the wet SRV recommended for a level surface where a user is likely to be turning or pushing is 40, the SRV for an external ramp of 1:20 should be 45, and a ramp of 1:12 should have an SRV of 49. Materials that can achieve this include floated concrete, glass-reinforced plastic (GRP)/aggregate systems and some epoxy coatings with granular aggregate. Profiled surfaces should be specified only after careful consideration as they may not give the perceived slip resistance (see section 3.13.1). The frictional characteristics of the landing and ramp surfaces should be similar.

Table 7 Additional slip resistance required for ramps

Length of ramp (m)	Maximum gradient	Estimated additional SRV
10	1:20	5
5	1:15	6.7
2	1:12	8.3

This sloped access is designed as part of the platform in this lecture theatre and provides a non-intrusive step-free access to the platform in a limited space

An internal profiled metal ramp in an airport gives a light appearance and is hard wearing and easy to clean. Note that the guarding is higher than the handrails and that the lower rail provides protection to the glass and a tapping rail

External ramps

If drainage is likely to be a problem, the use of a pervious surface should be considered. It is important that external ramps are kept clear of snow and ice, which will create a slip hazard.

Internal ramps

Deep-pile carpet should not be used on ramps as its resistance increases the effort needed to propel a wheelchair.

4.3.10 Handrails

See section 4.4 and Figures 8 and 9.

Healthcare buildings

Where handrail and wall protectors are provided there should be a minimum vertical distance between them of 50mm. Where the wall protector protrudes in front of the handrail, the clear width of the ramp will be between the wall protectors.

4.3.11 Guarding

A continuous upstand or kerb at least 100mm high, or an equivalent barrier such as a rail or planter, should be provided on the open side of any ramp or landing to act as a tapping rail for visually impaired people and to prevent wheelchair wheels falling over the edge of the ramp (Figures 5 and 6). This should be in addition to any guarding required under Part K. It should contrast visually with the ramp and landing surfaces.

Barriers should be designed as for steps and stairs, in accordance with AD K, or equivalent national regulations and BS 6180:1999.

A continuous metal low rail protects the glass barrier on either side of the freestanding ramp and provides a tapping rail

4.3.12 Lighting

If possible, ramps should be located, orientated and surfaced to avoid glare and cross-shadows, which could prevent people with visual impairments distinguishing the change in gradient.

Artificial lighting should be evenly distributed with an illuminance of at least 100 lux on the ramp surface and the landings.

4.3.13 Ease of cleaning

To facilitate cleaning, the surface of ramps should be clear of any obstructions such as guarding or handrail fixings: these should preferably be on or outside the kerb or tapping rail.

4.3.14 Temporary and portable ramps

In situations where for whatever reason a permanent ramp cannot be installed in an existing building, a temporary ramp may be a reasonable solution, although when designing new buildings this would not be acceptable. They may also be used until a permanent solution, such as a lift or permanent ramp, can be constructed or installed. In general, the design of temporary ramps should follow the recommendations above for external ramps. Temporary ramps can be either fixed or portable.

Some temporary ramps, designed in keeping with the building, become permanent

Temporary ramps, especially long or heavy ones, can be awkward to handle. It may also be difficult to provide a top landing of the recommended size. A rise of 600mm at a gradient of 1:12 is an effective maximum in most instances. They should be firm and secure in use.

If portable or temporary ramps have to be used to give access to an existing building where space is limited, they should be positioned and their presence identified so that they do not constitute a hazard to passers-by.

These ramps should have a clear width of at least 800mm, a drainable, slip-resistant surface and upstands to prevent wheelchair tyres veering off the edge. Two-channel ramps are not recommended.

This temporary ramp to an office building is in two parts to accommodate two steps with different height risers. The two parts of the ramp may not stay together or aligned and the projection into the pavement could cause a trip hazard for pedestrians

An inelegant temporary ramp to a listed office building that projects out into the pavement, providing a potential trip hazard

This temporary ramp in an external exhibition area has been sympathetically designed to integrate with its surroundings and provides a firm surface for wheelchair access across a sloping grass area

Portable ramps will require storage space, trained staff who are familiar with their use and management procedures in place to ensure their safe and effective use. Where a portable ramp is to be used there should be a suitably placed call button to call for assistance.

4.4 Handrails for steps, stairs and ramps

4.4.1 Provision

At least two handrails, one on each side, should be provided on all flights of steps, stairs and ramps over the whole length of the flight so that people can choose which arm they use or can use both handrails. They should be continuous around intermediate landings and should not be interrupted by newel posts or other supports. Where there are doors on landings, this continuity may not be practical. A possible solution where a door is not in constant use is to have a swivelling section of the handrail attached to the door.

The handrails on this staircase in a museum have a circular profile, contrast visually with their surroundings, are continuous around the landings, have a central double handrail, and have horizontal extensions at the landings to indicate the top and bottom of a flight. Note that, although the shiny surface of the landing causes reflection, low-level wall lighting helps reduce this, highlights the steps and is easier to maintain

4.4.2 Dimensions

The minimum width between handrails should be 1000mm. On wide flights of steps or stairs, handrails should be used to divide the flight into channels. AD M requires that steps or stairs with an overall unobstructed width greater than 1800mm are divided into two or more channels between 1000mm and 1800mm wide; BS 8300:2009 extends 1800mm to 2000mm. Consideration should be given to using double handrails rather than a single rail for dividing flights to avoid hand clashes of people travelling in different directions on either side, but care must be taken that this does not affect the capacity of stairs used as a means of escape.

On wide steps, central handrails do not need to be evenly spaced provided that at least one channel meets the recommended dimensions

Rail stations

A central handrail is recommended on stairways wider than 4000mm.

London Underground Limited

The minimum dimension between handrails should be 1200mm for a single staircase and 2400mm for a two-way staircase.

The height to the top of the principal handrail should be between 900mm and 1000mm above the pitch line of the steps or stairs, or above the surface of the ramp. On landings, the recommended height for the top of the handrail is between 900mm and 1100mm from the floor surface, 1100mm being the required height for guarding on landings (Figure 8). However, at 1100mm, the handrail is too high to fulfil its function as a support for many people. In addition, the difference in height between a handrail on the steps or stairs at 900mm from the pitch line and a handrail at 1100mm on the landings means that the handrail on the stairs cannot extend fully to the bottom of the steps or stairs, and extends beyond the top of the stairs or has a vertical rise, which may be misleading and confusing to people with visual impairments

Handrails that are independent of the guarding allow the guarding to be higher than 1000mm and, as in this public office building, can provide protection to the glazed balustrade

using them for guidance. It is therefore advisable to provide handrails at the same height, 900–1000mm, for steps and landings, with independent guarding.

For all environments and buildings used by the general public and/or designed for children, there should be a second (lower) handrail set at 600mm. This will also be of benefit to those of short stature. However, a lower handrail can act as a climbing frame and should not be used where the handrails are also acting as guarding or where children may

Children, and people of short stature, benefit from having a lower handrail: in this museum this girl is using one of the guarding rails to hold on to. However, these horizontal rails are climbable and therefore potentially dangerous

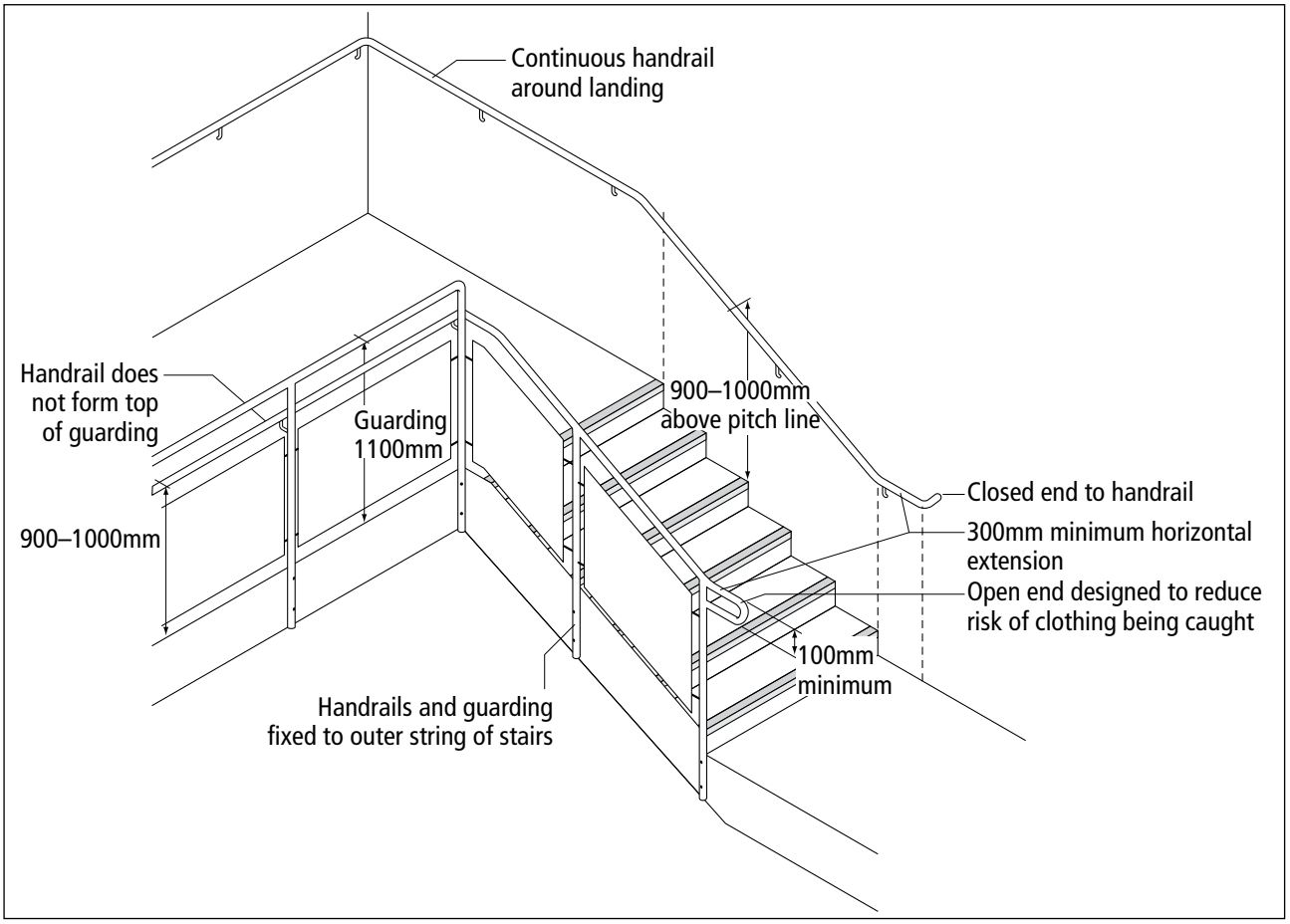


Figure 8 *Handrails and guarding*

be uncontrolled, such as in a shopping centre; where necessary, structural guarding should be provided in addition to, and separate from, the handrails.

Handrails should continue horizontally beyond the end of the stairs or ramp slope by 300mm minimum; this helps visually impaired people know when they have reached the top or bottom of a flight, and allows people with mobility impairments to steady themselves before ascending or descending the steps. This extension must not project into an access route, and should be finished by being returned to the wall or curved downwards for a minimum of 100mm to reduce the risk of catching clothes.

Circular handrails should have a diameter of 32–45mm; oval profiles should be 50mm wide by 38mm deep, with a radius of 15mm. These are easy to grip and can provide adequate physical support; a flatter profile provides better forearm support. Handrails with large square or rectangular sections should be avoided as they are uncomfortable to grip.

Healthcare buildings

A second, lower handrail is recommended on all ramps, for wheelchair users, and on stairs and landings in children's healthcare facilities and other healthcare premises where there are likely to be a significant number of semi-ambulant users.

An extension of 450mm is recommended, provided it does not interrupt a pedestrian route.

Rail stations

European standards state that the height of the higher handrail should be

850–1000mm above the pitch line of the steps or surface of the ramp, and the lower handrails should be at a height of 500–750mm above floor level. The latter must not constitute a safety risk.

London Underground Limited

Lower handrails must be 550–650mm above the pitch line of the stairs.

There must be a clear unobstructed vertical distance above the top of the handrail of 600mm.

Double central handrails must have a clear horizontal separation of 150 ± 10mm.

Centre handrails must break at every landing with a clear gap of 1800mm minimum where there is two-directional flow on stairs or ramps.

Where practical, handrails should extend horizontally 600mm beyond the top and bottom riser or end of a ramp.

Although the end of this handrail to a ramp does not extend horizontally, it is identifiable by the textured end

Well-designed extensions and handrail ends

Schools

For schools for children under 12 years old, the second lower handrail should have a diameter of 40–45mm.

Healthcare buildings

The recommended diameter of circular handrails is 40–45mm.

Rail stations

The European standard states that a rounded handrail with a cross-section width of 30–50mm is required.

London Underground Limited

LUL specifies a circular profile 40–50mm in diameter.

4.4.3 Fixings

Handrails should be supported centrally on the underside so that there is no obstruction to the passage of the hand along the rail. They should not protrude more than 100mm into the surface width of the stairs or ramp if this would reduce the stair or ramp width requirements, nor should the inner face of the handrail be more than 50mm beyond the surface width of the steps, stairs or ramp (Figure 9). There should be clearance of 60–75mm between the handrail and a wall, which allows a forearm to be rested on the rail without any danger of it being trapped, and clearance of more than 50mm between the underside of the handrail and a cranked support. Recessed handrails are not recommended as they cannot be used for support.

Handrail fixings must be sufficiently secure to support a person grasping them to prevent or arrest a fall. They should be designed to meet the loading recommendations in BS 6399-1:1996, and should take account of the substrate material, including the position of any reinforcing in concrete, and the spacing between fixings.

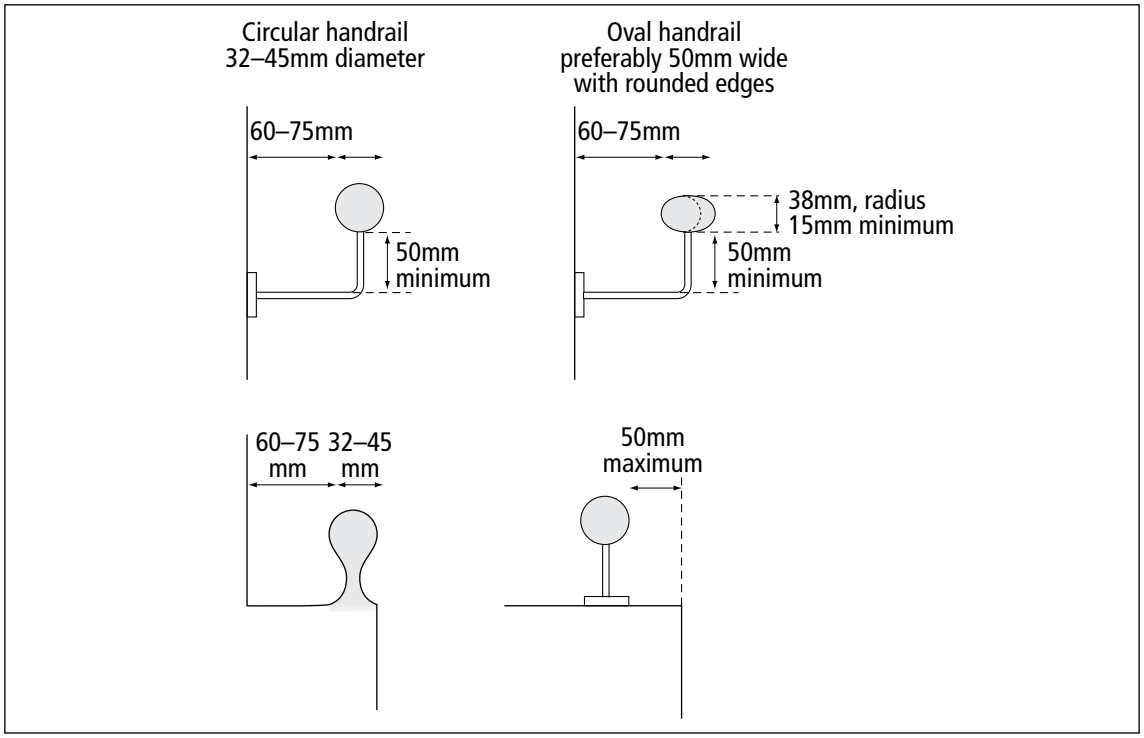


Figure 9 *Handrail profiles and dimensions*



Different handrail fixings that that enable a hand to slide along the rail without interruption

Rail stations

The European standard states that the minimum clear space required between the handrail and other parts of the structure is 40mm.

London Underground Limited

The minimum clear space required between the handrail and a wall is 45–60mm.

Handrails on internal stairs can have tactile markers on the upper surface at the beginning and end of each flight indicating the floor level reached. This is particularly helpful when the handrail continues along the wall of a lobby or corridor. However, there is currently no clear guidance on the use of tactile markers, their size, shape, position and spacing, which is likely to make their use less effective as each application will vary. If tactile indicators are used, this should be explained in any visitor or building user information.

4.4.4 Finishes

Handrails should have a smooth, but not reflective, continuous surface and should contrast visually with their surroundings.

External handrails should have an insulated finish so that they are not cold to the touch, even in winter; surfaces such as hardwood or nylon-coated steel are recommended. Where resistance to vandalism and/or low maintenance are key factors, stainless steel may be the only option. In summer, dark-coloured handrails are likely to get hot if they are in direct sunlight as they will absorb the heat rather than reflect it.

Rail stations

The European standards state that 'if there are handrails (or walls) within reach along the obstacle-free route to the platform, they should have brief information (for example, platform number or direction information) in Braille and in prismatic letters or numbers at the rear of the handrail, or on the wall at a height between 850mm and 1000mm. Numbers and arrows are the only permissible tactile pictograms'.

This external stainless-steel handrail to an office building has raised profiles on the top to prevent youngsters using the handrail as a slide: these will prevent people being able to easily move their hand up or down the rail and the stainless steel will be cold to the touch in winter

A blue band has been put behind this handrail in a London Underground station to provide greater visual contrast

4.5 Escalators and moving walks

Escalators

Escalators have been in public use since the early 1900s, and pallet-based moving walks since the 1950s. Escalators are typically used for movement between adjacent floors and are commonly found in places where there are large numbers of people to be transported between floors, such as shops, shopping centres, transport terminals, hospitals, offices, museums and exhibition centres, together with stairs and lifts. In the older underground rail systems, escalators are often the principal means of vertical movement. Escalators provide an immediate means of transportation, whereas lifts generally necessitate waiting time and have limited capacity.

However, many people, particularly those with a mobility or visual impairment, find escalators difficult and frightening to use, and they are not suitable for wheelchairs, prams, pushchairs or people with assistance dogs unless the dog can be carried. Therefore, lifts, as the preferred method of vertical transport for wheelchair users and people with assistance dogs, should be provided near to escalators where there are substantial changes in level, and should be clearly signed.

Side-by-side escalators in the concourse of a mainline station provide easy and immediate access to and from the first floor and street level. Note the clear signage to the lifts as an alternative means of access at the top and bottom of these escalators

Escalators are the main means of access in London Underground stations. Note that the flat area between the escalators has 'obstacles' on it to prevent being used as a slide

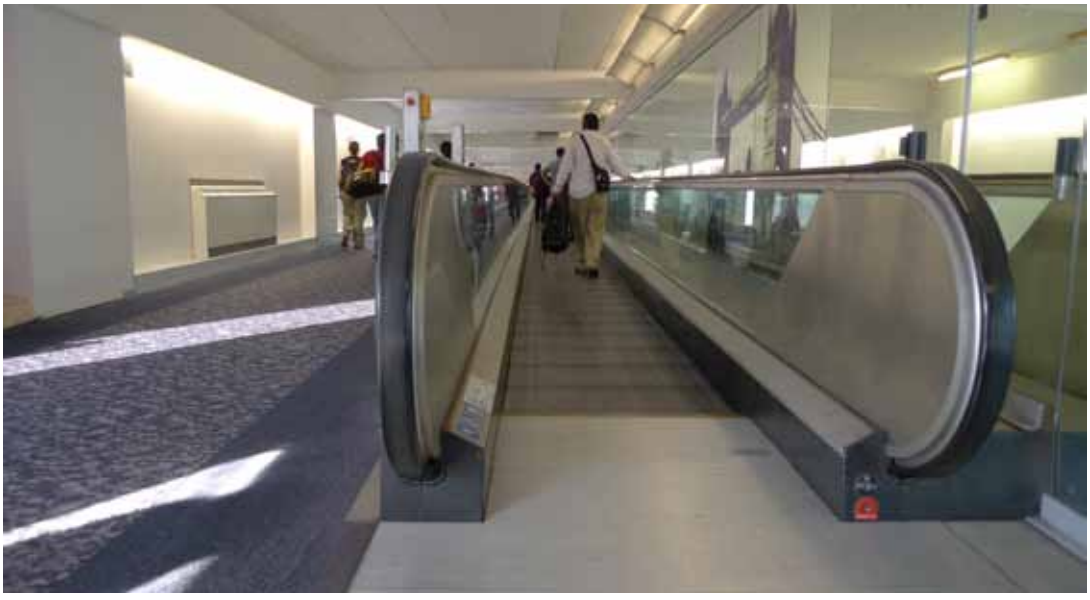
Falls on escalators are likely to cause injury on account of the sharp, usually metal, edges to the treads. Trips and falls mainly occur at the top and bottom of escalators during access or egress. There are also many accidents as the result of trapping clothes, fingers and toes, particularly of infants.

Moving walks

Moving walks, also called moving walkways, travelators or passenger conveyors, where the moving surface is flat and parallel to the direction of travel, can be horizontal or inclined. Horizontal moving walks are used where there are substantial distances to be travelled, for example in airports and stations, and are helpful to many people. Inclined moving walks are used where there is a small change in level or where a flat surface is required, for example for shopping trolleys. However, as with escalators, some people find it difficult or do not like to step onto a moving walk.

There are two types of moving walk: a continuous moving belt or interlocking pallets. The latter is more common.

As with escalators, accidents are more frequent at the access and egress points: elderly people seem to be more at risk. Other causes of accidents are water contamination causing slips where moving walks are adjacent to external areas and the misuse of trolleys or trapping of their wheels.



A pallet moving walk in an airport assists people, often encumbered by luggage, to cover long distances more easily

Although buggies are not really meant to go on escalators, escalators are easier to use than stairs where no lift is provided

Escalators and moving walks

Some escalators and inclined moving walks can convey shopping or baggage trolleys, provided that both are designed with appropriate and compatible locking devices. The trolley's width must be at least 400mm less than the pallet width. Trolleys for use on escalators are covered by EN 1929-2:2004.

Design factors affecting the usability and safety of escalators and moving walks are:

- speed
- inclination
- step/pallet width
- identification
- landings clear space
- finishes
- handrails
- guarding
- lighting
- signs and information

All escalators and moving walks must, since 1 January 1997, be CE marked and have a

Trolleys that lock on to the pallets of a moving walk or escalator are increasingly used in supermarkets, shopping centres and transport facilities

declaration of conformity; in most cases certificates compliant with BS 5656-1:1997 are issued by the manufacturer.

Under the *Health and Safety at Work Regulations* employers and self-employed people are responsible for carrying out a risk assessment for the safe operation of escalators and moving walks within their premises. This is likely to include a standard, generic assessment and specific assessments in relation to particular locations, use or circumstances. All potential hazards in relation to each of the design issues should be considered and assessed, as well as mechanical failure and human error and behaviour. The risk assessment may necessitate special management measures being put in place to mitigate the risks.

Escalators and moving walks are also required to have an instruction handbook relating to use, maintenance, inspection, periodic checks and rescue operations.

Escalators and moving walks are machines and must comply with the Supply of Machinery Regulations (Safety) 2008 and PUWER 1998, which include a number of essential health and safety requirements. Their use may also come under The Workplace (Health Safety and Welfare) Regulations 1992. The design guidance given below is mainly drawn from BS EN 115-1:2008 and more detailed guidance is contained within this document. Additional guidance is from BS 5656-2:2004 (see **Section 2**).

4.5.1 Provision

Escalators and moving walks are categorised according to the intensity of their use (Table 8).

Escalators

The number and size of units depends on the type of premises and the estimated traffic flow, particularly at peak times, with an allowance for non-operational time for maintenance or replacement. Normally there should be at least two escalators at each location to serve traffic flows in each direction.

Stairs and/or lift(s) should always be provided as an alternative means of access. If an accessible lift is provided, it should be located nearby for those unable to use escalators and clearly signed from the top and bottom of the escalator.

Table 8 Escalator and moving walk categories (from BS 5656-2:2004)

Category	Typical usage (passengers per day)	Typical locations
Light	Up to 3000	Shops, museums, libraries, leisure facilities
Medium	Up to 10,000	Department stores, shopping centres, regional airports and stations
Heavy	Up to 20,000	Major railway and underground stations, international airports
Intensive	Over 20,000	Critical locations such as underground systems

Healthcare buildings

The principal means of vertical access in healthcare buildings is lifts, but escalators are being increasingly used in the entrance/reception areas of larger hospitals for access to second and third floors. A particular consideration may be the need for hosing down for hygiene or decontamination for infection control.

Escalators in the main entrance of a hospital provide easy access to the first floor. Lifts and stairs are also provided. Note the visually contrasting floor surfaces at the foot of the escalators

Shopping centres

In shopping centres, escalators and inclined moving walks often provide the main means, other than stairs, of moving between floors. Research has shown that 80 per cent of shoppers will use escalators. The traffic demand, and hence the number of escalators, is difficult to estimate, but a pair of escalators every 100m of mall length is normally considered sufficient. Where department stores within a shopping centre have escalators inside the store, these should not be taken into account in determining the requirements for the whole centre. The width of escalators in shopping centres is normally 800mm or 1000mm.

Criss-cross escalators in the atrium of a department store provide immediate access to all floors with views of each floor en route

Office buildings

Escalators in office buildings are normally used to serve the lower two or three floors to relieve congestion on lifts. In estimating capacity, it is normally assumed that 90 per cent of people wishing to access these floors will use the escalators. Where there are a series of escalators, the lowest escalators will carry the most people and should be sized accordingly. The number of escalators required will depend on the estimated staff arrival rate. Being able to reverse the direction of the escalators in peak periods so that they are all in the same direction may enable the number of units to be reduced. Where no queuing can be tolerated, the escalators should be sized to meet twice the average arrival rate indicated.

London Underground Limited

LUL has its own method of calculating the number of escalators required based on the peak one-way flow per minute divided by 100 – the assumed capacity of passengers per minute.

In all new LUL stations a three-escalator shaft is required to accommodate potential growth in passenger numbers and allow for one escalator being out of service owing to maintenance. Escalators in the underground system are likely to be used for emergency escape (see section 4.6).

Moving walks

Moving walks usually form part of a main circulation route, and may be a single walkway where there is unidirectional traffic only, or in pairs where there is traffic in two directions or one walkway would not provide sufficient capacity.

There should always be a parallel passageway beside each horizontal moving walk and alternative lift access, clearly signed, where there are inclined moving walks.

Moving walks in either direction in a London Underground station, with a central walkway, have clear directional and wayfinding signage

4.5.2 Location

Escalators and moving walks are normally provided in internal environments, and are not generally recommended for external use in the UK, but can be used if they are adequately covered to protect them from the weather. They are used in external situations in other countries, for example some German metro stations and some ski resorts. Where they are exposed or partially exposed, they should be protected to prevent direct water ingress, and weather-resistant controls should be employed.

Escalators and moving walks are usually sited in obvious circulation paths making it easy for pedestrians to board them. They must be accessed from a landing or lobby area where there is sufficient space for people to wait for access or egress without blocking circulation routes (see section 4.5.10, *Landings*).

External escalators and stairs from a station to street level are covered by a glazed semi-circular canopy, which also helps to identify the entrance to the station

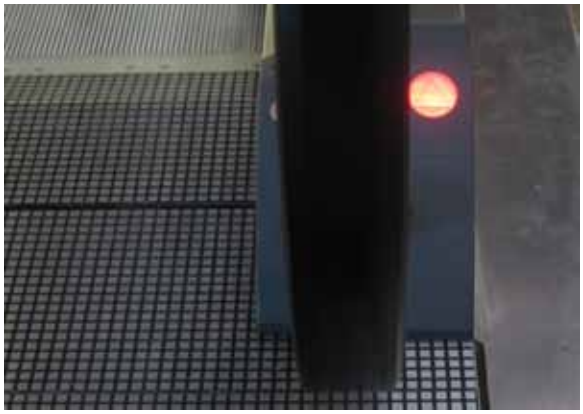
Rail stations

In stations, if escalators give directly onto a station platform, they should be aligned along the length of the platform, that is, parallel to the tracks.

4.5.3 Signage

At the top and bottom of all escalators there should be clear visible signage indicating an alternative accessible route, such as a lift.

The direction of travel of these escalators in a public building is clearly signed and easily visible



The direction of travel is often indicated by small red or green lights at skirting level, which may be difficult for a visually impaired person to see

Where there are parallel side-by-side escalators or moving walks, there should be clear signage indicating the direction of travel, particularly where this may be changed to accommodate peak flows. Where escalators or moving walks start automatically on approach, clearly visible signs, such as traffic lights, should indicate if the escalator is available for use, and the direction of travel.

Wayfinding signs, advertising and retail displays should not be located close to the top and bottom of escalators or at the ends of moving walks as people stopping to read or look at them can block the access or egress, which can create a potentially dangerous situation.

Escalators and moving walks are required to display mandatory safety signs in accordance with BS EN 115:2008. These include:

Small children shall be held firmly

Dogs shall be carried

Use the handrail

Pushchairs not permitted

Ideally, information should be given in alternative formats, with visual signs, written and symbols, being reinforced with audible information to assist those with visual impairments.

Safety signs are displayed in a variety of ways: on the top of the skirting, on the balustrade or on a vertical board

4.5.4 Capacity

Escalators

The capacity of escalators depends on their speed and width (Table 9) (see **section 4.5.7** and **section 4.5.8**, *Width*, below).

The direction in which an escalator is travelling can normally be reversed: this can help with peak flows of people all travelling in the same direction.

The use of shopping trolleys or baggage carts that lock onto the pallets will reduce the capacity by approximately 80 per cent.

Moving walks

BS EN 115:2008 specifies that the capacity of moving walks is the same as escalators, but CIBSE states that experience suggests a reduced density of 2 persons/m^2, giving the capacities shown in Table 10.

Where the width of a moving walk is wider than 1000mm, the capacity will not be increased as users generally need to hold the handrail: the additional width is mainly to accommodate shopping trolleys, if applicable, and luggage.

Table 9 Practical handling capacity of escalators in persons/hour (CIBSE)

Step/pallet width (mm)	Nominal speed (m/s)		
	0.5	0.65	0.75
600	2250	2925	3375
800	3375	4388	5063
1000	4500	5850	6750

Table 10 Practical handling capacity of moving walks in persons/hour (CIBSE)

Incline (°)	Speed (m/s)	1000mm wide	1400mm wide
0	0.5	3600	5040
0	0.65	4560	6350
0	0.75	5400	7560
6	0.5	3600	5040
10	0.5	3600	–
12	0.5	3600	–

4.5.5 Configuration

Escalators and inclined moving walks

There are three main configurations of escalators (Figures 10–13). Scissor escalators require a larger structural opening than the other two configurations and create a higher risk of falling and complicated maintenance activities. The arrangement selected will depend on the type of premises and the space available.

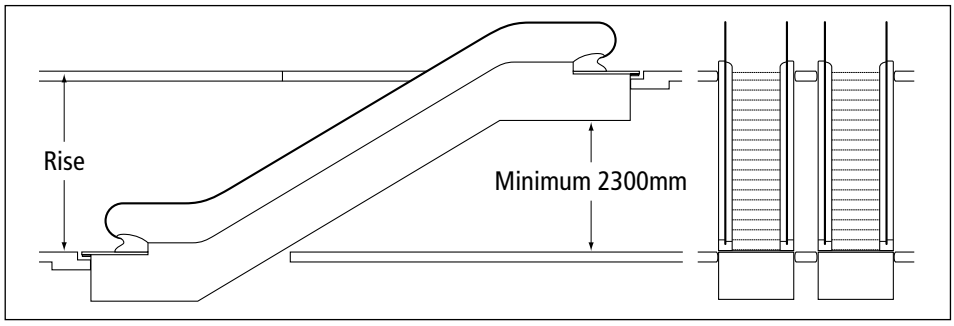


Figure 10 *Side-by-side escalators, which provide a short transition route between successive escalators*

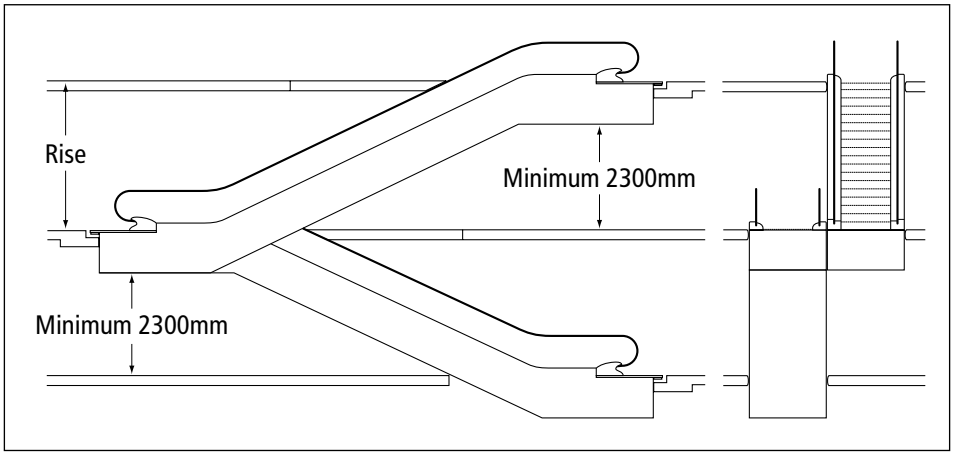


Figure 11 *Single-scissor escalators provide a short transition route between successive escalators*

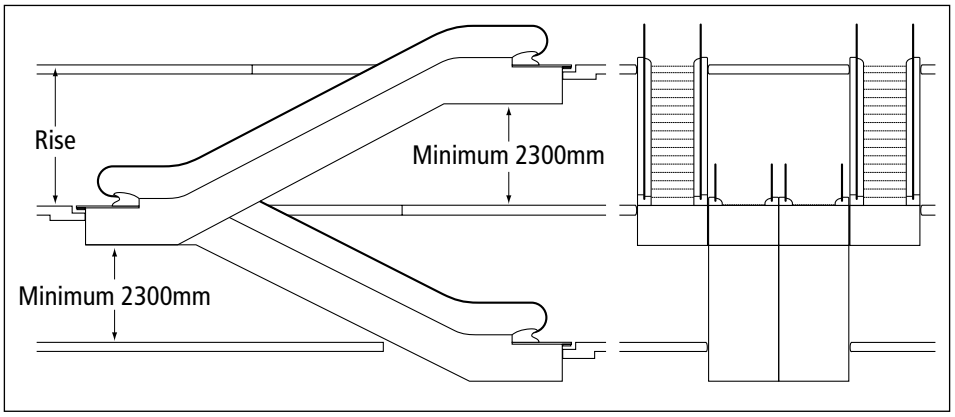


Figure 12 *In double-scissor escalators the direction of the escalators can be arranged to provide either a short or a long transition route*

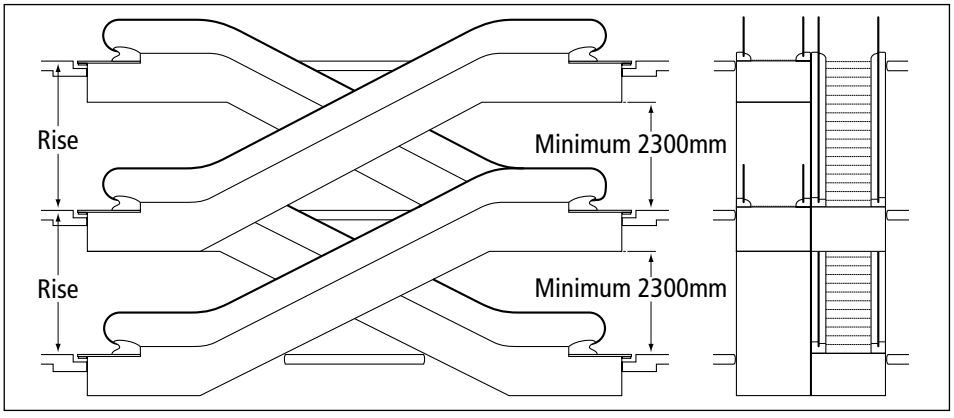


Figure 13 *Criss-cross escalators have a longer transition route between successive escalators and are often used in department stores so that shoppers have to walk through display areas to reach the next escalator*

4.5.6 Angle of inclination

Escalators

The generally recommended maximum angle of inclination is 30° (see Figure 14). An inclination of 35° is permitted for vertical rises less than 6m and where the speed is less than 0.5m/s. The inclination of escalators should be selected to take account of the location and the estimated levels of use, particularly by people with mobility impairments.

Escalators should have at least two or three flat steps at the top and bottom, depending on the speed and rise, to allow safe and easy access and to enable people with poor balance to adjust to the movement (Table 11). These numbers should be increased if a large number of disabled people are likely to use the escalators.

Table 11 Minimum horizontal distances at top and bottom of escalators

Speed	Rise	Minimum horizontal distance of level steps from comb interface (mm)
Less than 0.5m/s	–	800
Greater than 0.5m/s and less than 0.65m/s	–	1200
Less than 0.65m/s	Greater than 6m	1200
Greater than 0.65m/s	–	1600

Flat steps at the top of an escalator are required to facilitate people getting on or off a moving surface. Note the yellow line marking the front of the treads and the side lighting set into the balustrades, which helps to highlight the step edges

This department store has extended flat steps at the top and bottom of the escalators to take account of shoppers who are likely to be moving more slowly because they are looking around at the displays. Note the strip lighting along the skirting either side of the escalator, and the clear floor-level signage

Falls on boarding and leaving are the most common accidents.

The transition radius required is determined according to the speed and angle of inclination.

Moving walks

Where a moving walk is intended to be used by wheelchair users, the angle of inclination should not be greater than 6°, equivalent to approximately 1:9, as there is a risk of tipping and/or slipping at steeper gradients. The maximum recommended angle of inclination for a moving walkway is 12° (1:4.5).

Where the inclination is greater than 6°, the moving walk must have an upper and lower transition curve so that the pallet or belt is flat (moving at an inclination of less than 6°) for a distance of at least 400mm before entering or leaving the comb.

Inclined moving walk in a London Underground station, with flat pallets at the bottom and visually contrasting textured surface at the landing

Shopping centres

Inclined moving walks are being increasingly used in shops and shopping centres, with trolleys that lock onto the pallets. The typical inclination is 10°.

4.5.7 Speed

Escalators

The maximum speeds recommended for escalators are 0.75m/s where the angle of inclination is 30° and 0.5m/s for inclinations of 30–35°. (CIBSE recommends a speed of 0.4m/s.) For comparison, the average walking speed is 1m/s. The slowest speed compatible with traffic needs should be specified as this helps people who move more slowly.

Healthcare buildings

The recommended speed of escalators in healthcare buildings is 0.5m/s at an inclination of 30°.

Rail stations

The European standard states that escalators in stations should have a maximum speed of 0.65m/s.

Moving walks

The speed of a moving walk should be kept low: 0.5m/s is recommended, with 0.75m/s maximum. If the walkway is inclined, the maximum speed recommended is 0.5m/s.

Escalators and moving walks

Some escalators and moving walks are designed to start moving only when someone approaches, and others have a 'slow run' option whereby the escalator or moving walk runs at 10 per cent of the operating speed during periods when there is no-one on it and speeds up as someone approaches; both of these reduce energy consumption. Escalators and moving walks that start automatically on approach should initially move more slowly, with a maximum speed of 0.2 × nominal speed being recommended, and then accelerate at less than 0.5m/s^2.

4.5.8 Dimensions

Width

Escalators

Escalators normally have a tread width of 600mm, 800mm or 1000mm. 1000mm is preferred as this gives an overall width between the interior panels of 1200mm, which will allow two people to stand side by side, and thus will accommodate people with walking aids or who need a companion beside them, and those carrying children, shopping or luggage.

Moving walks

The standard widths are 800mm, 1000mm and 1400mm up to 6° and 800mm and 1000mm above 6°.

Healthcare buildings

The recommended width in healthcare buildings is 1000mm, to allow people who require assistance to have an accompanying person standing beside them.

Where escalators are parallel and beside each other the distance between the outside of the adjacent handrails should be a minimum of 160mm.

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LUL calculates the moving walk width required by assuming 100 passengers per minute per metre width at a speed of 0.75m/s. The minimum width is 1200mm, or 1400mm where luggage trolleys are permitted.

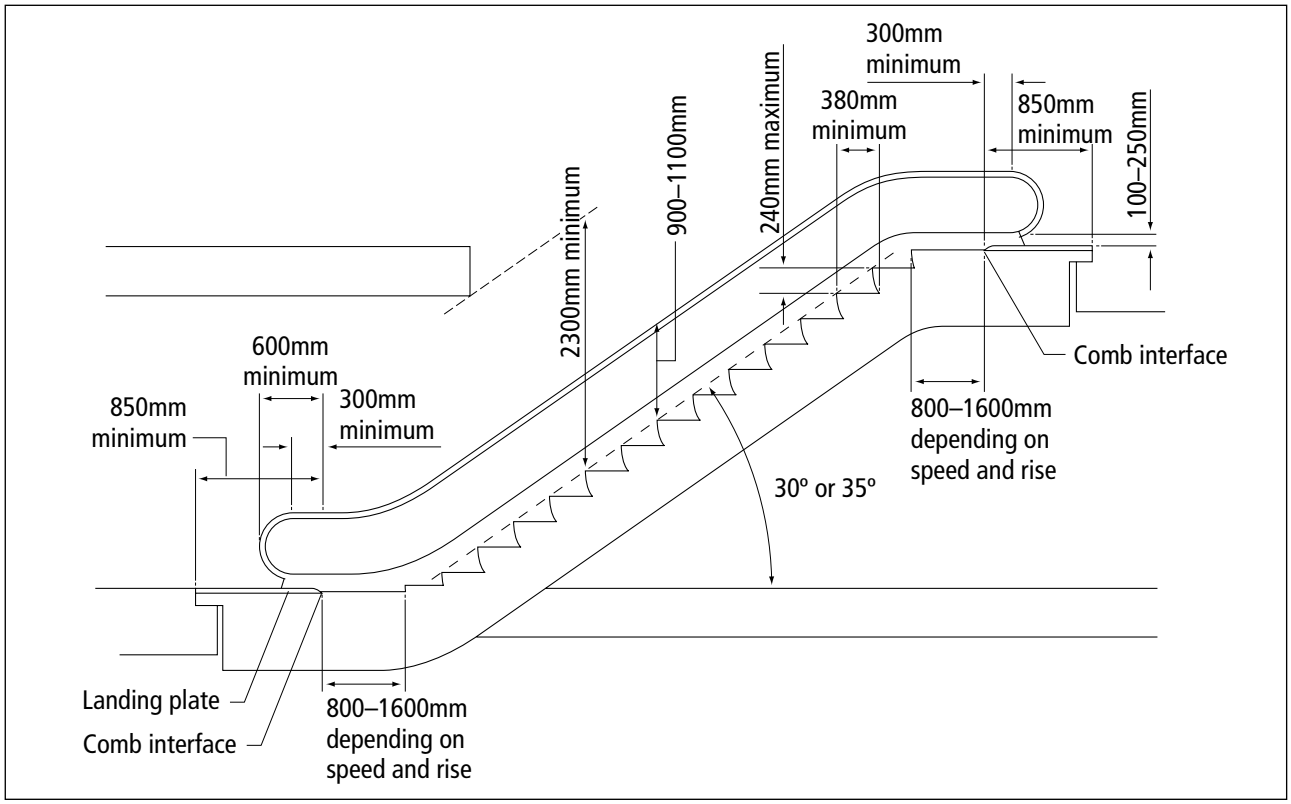

Figure 14 *Principal dimensions*

Treads and risers

Escalators

The depth of the treads should be greater than 380mm and the step height less than 240mm (Figure 14).

Escalators, even when they are static, should not be considered as steps or stairs. The risers are higher than the recommended height for steps and stairs, which means that people are likely to go up or down more slowly, and the risers towards the top and bottom are of varying heights, which could result in trips and falls. In addition, escalators tend to be very long flights with 25–40 steps, which would be difficult for many people. People approaching a static escalator still tend to expect that it is moving, and this may affect their balance momentarily as they step onto it. If the escalator is to be used as a static stair, in some cases as a means of escape, the riser height should be reduced, but this will increase either the pitch or the length.

Rail stations

The recommended riser height is 210–240mm if escalators are to be used as an emergency exit when stationary.

London Underground Limited

For escalators in atriums, LUL requires a clear height of 3m above landings and over the whole length of the escalator, measured to the lowest point of the ceiling, equipment or suspended signs. Where local obstacles protrude downwards, the height must be no lower than 2.4m over a maximum length of 2m.

Headroom

BS EN 115:2008 recommends a clear height above escalators of 2.3m with 2.1m clear outside the handrails (Figure 14).

4.5.9 Flight rise

Escalators

No maximum rise is specified, but normally escalators go between adjacent floors. Longer escalators over the equivalent of more than one floor are found in some new buildings and, more traditionally, in deep underground systems.

This escalator goes up two storeys, whereas the one underneath goes up one storey. This can reduce congestion at the lower floor and control access to different levels of the building

Shopping centres

For shopping centres the maximum rise recommended is 6m, that is, two storeys.

4.5.10 Landings

Escalators and moving walks are required to have a static level landing (comb) plate at either end of at least 850mm in length from the root of the comb interface (Figure 14).

Beyond the landing plate there should be clear areas to allow for queuing and safe movement onto and off the escalator, particularly for those who move more slowly. One of the greatest hazards is a blocked egress from an escalator. These unrestricted areas should have a width of at least the distance between the outer edges of the handrails plus 80mm each side and be 2.5m long from the end of the balustrade. The length can be reduced to 2m if the width is increased to at least twice the distance between the outer edges of the handrails plus 80mm on each side; note that this unrestricted space is about 60 per cent larger than the longer one (Figure 15).

In some places, such as airports, barriers or bollards are placed at either end of escalators and moving walks to prevent people taking trolleys or other large wheeled items on to them; such barriers must be positioned so that they do not impinge on the unrestricted area or cause obstructions.

Where there are successive escalators or moving walks, each should have at least a clear unrestricted area as above at either end: successive equipment must not share unrestricted areas. If there are intermediate entrances and exits or cross-pedestrian routes, the intermediate landings should be increased in length.

Where escalators or inclined moving walks have a locking device for trolleys it is recommended that the unrestricted landing areas are increased to 5m.

Escalators

Where there are intermediate entrances and exits or cross-pedestrian routes, BS 5656-2:2004 recommends an increase in length of a minimum of 0.5m for single escalators and 1m for pairs of escalators.

In heavily trafficked, multilevel locations, where there is vertical access up through several levels, extending the landing plate and moving handrail beyond the end of the moving treads helps to mitigate conflict between those getting off, those going directly to the next escalator and those joining the travel path to the next escalator.

A spacious landing at the top and bottom of escalators minimises the risk of congestion and blocked egress. Note the extended landing plates and moving handrails, which help to mitigate conflict between people moving directly to the next escalator and those wanting to access or leave that floor level

Posts define the landing area between two moving walks and facilitate free movement while still allowing people to exit at that point

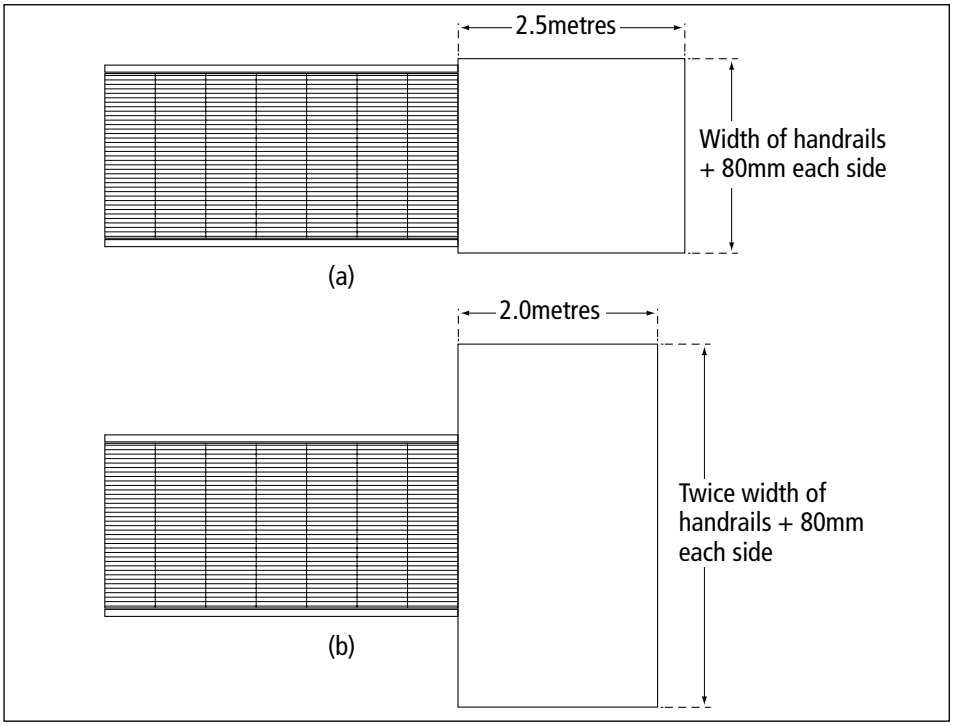

Figure 15 *Escalator and moving walk landings*

Rail stations

A clear area 5m or more in length is recommended at the top and bottom of escalators, if possible; this should be increased in heavily trafficked areas.

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For underground stations, LUL has the requirements shown in Table 12.

Table 12 LUL clear unrestricted areas

Circulation	Situation	Minimum distance (m)
Two-way	Escalator to passageway	6
	Escalator to street	6
	Escalator to staircase	6–10
	Escalator to escalator	8–12
One-way	Escalator to gateline	8–12
	Gateline to escalator	6–12

4.5.11 Visual identification

The surface of the escalator or moving walk should contrast visually with the immediate approach to aid people with visual impairments, but the coefficients of friction of the two surfaces should be similar (see section 4.5.14). A visually contrasting demarcation at the comb plate edges is recommended.

Visually contrasting surfaces at the top and bottom of escalators assist visually impaired people to identify a change in level

Rail stations

The approaches to the top and bottom of escalators should be indicated by a change in floor colouring using a slip-resistant ridged standard plate.

4.5.12 Nosings

Escalators

There is no requirement in BS EN 115:2008 for visually contrasting nosings. Many escalators do now have a yellow line on the front or back edge of the tread, and sometimes also at each side, which helps users to see that the steps are moving. It also tends to discourage users from putting their feet too close to the sides or edges of the tread, where they may get rubbed or trapped.

Lighting can be used to create contrast between the treads and the risers (see section 4.5.17).

Yellow lines as a nosing help to indicate that the steps are moving

Healthcare buildings

It is recommended that the border of the step is painted with a yellow line.

In healthcare buildings it is recommended that there is a yellow line at the back and sides of the treads to indicate that the steps are moving; it also helps people to stand in the right place, not too close to the edge of the step. Note the wide yellow band marking the comb plate

Rail stations

The outer edges of the steps should be clearly defined in a contrasting colour, for example a yellow line.

4.5.13 Audible identification

In addition to visual and tactile identification, an audible signal or pre-recorded message indicating the start and finish of the escalator or moving walk is helpful to visually impaired people, but these are not normally supplied by the escalator manufacturer.

4.5.14 Finishes

BS EN 115:2008 recommends that treads and pallet moving walks should have grooves in the direction of movement (Figure 16). They should have a matt, non-reflective finish.

In areas where the treads may get wet, for example near entrances or in multistorey car parks, slip resistance needs to be considered. The coefficients of friction between the steps, the landing plate and unrestricted areas should be similar to minimise stumbling.

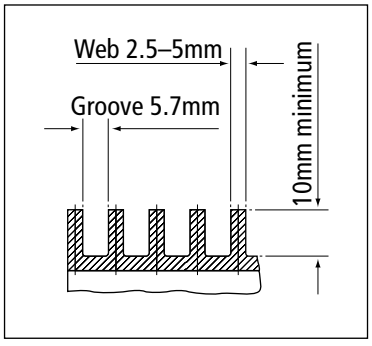


Figure 16 *Dimensions of ribbed finish for escalator treads and moving walk pallets*

Escalator step metal ribbed finish

Belt-type moving walks

For moving belts, the width of the grooves should be 4.5–7.0mm, with a depth of at least 5.0mm. The web width should be 4.5–8.0mm. The surface should provide a secure, slip-resistant foothold and be non-reflective.

4.5.15 Handrails

The moving handrail should be between 900mm and 1100mm above the step nosing or surface of the moving walk and, as with handrails on stairs, extend a minimum of 300mm at each end (Figures 13 and 17). The distance between the centre lines of the handrails should not be more than the distance between the skirtings plus 450mm. The width of the handrail should take account of the needs of those people with limited grip or manual dexterity; BS EN 115:2008 recommends a width of 70–100mm, with a flat top surface and rounded sides.

It is important that the handrail moves at the same speed as the escalator or moving walk as deviations in speed can cause falls. BS EN 115:2008 recommends a tolerance of –0 per cent and +2 per cent and that there should be a safety mechanism to stop the escalator if the speed deviation is greater than –15 per cent for more than 15 seconds.

The handrail should visually contrast with its surroundings and should incorporate a visual means of indicating that it is moving for the benefit of visually impaired people; CIBSE recommends yellow spots on the handrails, but these tend to wear off if not regularly maintained.

Rail stations

It is recommended that handrails have colour contrasting discs on them, 18mm in diameter and spaced at 1000mm, to indicate that the handrails are moving.

Yellow spots on the handrails of escalators and moving walks can help visually impaired people recognise that the handrail is moving, but they tend to wear off with use

4.5.16 Guarding

Guarding is required to minimise the potential risk of falls from escalators, and to prevent vandalism and abuse, such as climbing on the outside of balustrades or sliding down the area between adjacent escalators or escalators and walls.

Escalators should have guarding along each side, and at each end to prevent people with visual impairments from inadvertently walking onto to the escalator or being pulled over if they accidentally bump into the moving handrail.

It is recommended that the panels to the guarding on each side of an escalator should be angled at least 25° and preferably more than 27° to discourage children from climbing them (Figure 17). The panels should be smooth with no gaps greater than 4mm, should have a non-reflective finish and should not be back-illuminated as this can be very disorientating.

Guarding at each end that connects to the escalator should be at least the same height as the escalator handrails, 900–1100mm, and in any potentially hazardous situation it is recommended that barriers are 100mm higher than the handrails and positioned between 80mm and 120mm from the outer edge of the handrail (Figure 17).

This barrier in the form of a wall extends beyond the end of the handrail and prevents people in the main circulation area of this museum inadvertently walking into the moving handrails

A low, well-defined platform with a seat at the outer edge used to prevent people walking into the soffit of an escalator

The area underneath an escalator in a station can provide space for a small retail outlet or ATM

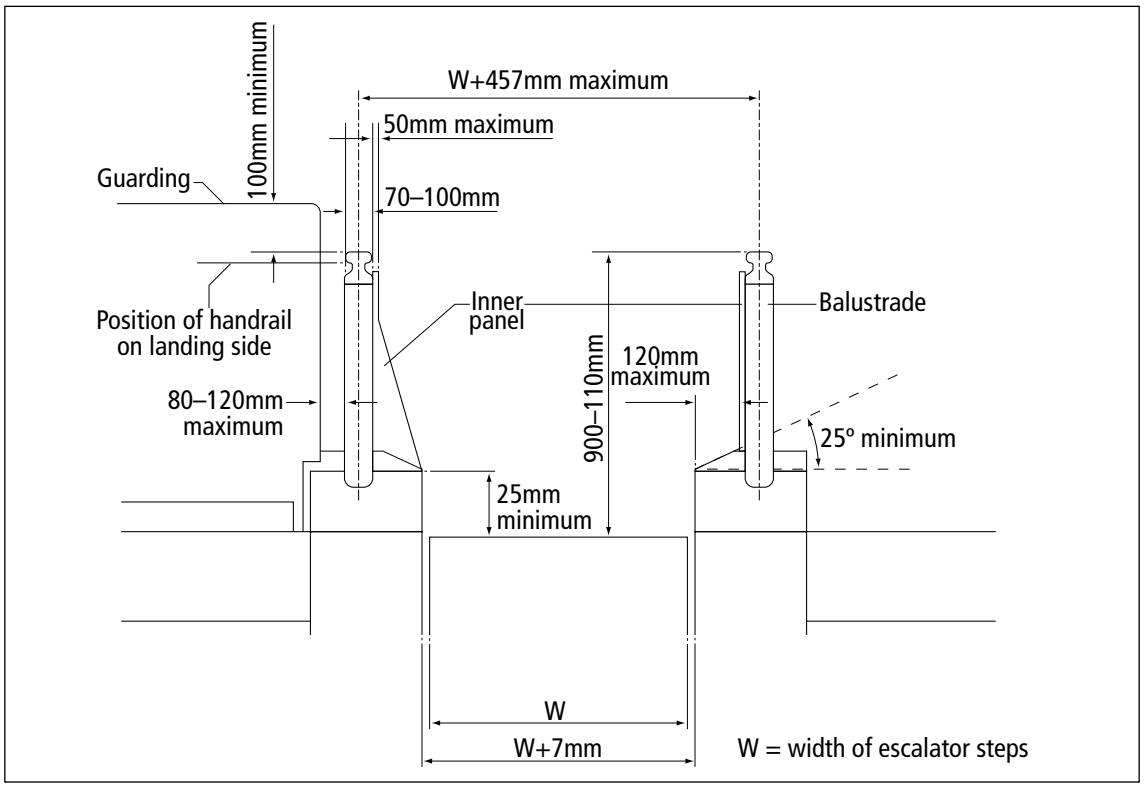


Figure 17 *Section dimensions and guarding*

Rail stations

Where an escalator can be approached obliquely, barriers should extend 10m in front of the escalator to protect visually impaired people.

Guarding is also required under the open soffit of an escalator or inclined moving walk where the clear headroom from floor level is less than 2100mm.

Detailed guidance on guarding, anti-climbing and anti-sliding devices and access restriction either side of the escalator to prevent misuse is given in BS EN 115:2008.

Guarding at the side of the inclined moving walk is higher than the handrail, as recommended, and has a protective rail at the bottom, and there is guarding at the end to prevent access. However, the unprotected end of the moving handrail could be a potential hazard to people with visual impairments, although there is clear visual contrast of floor surface

4.5.17 Lighting

Escalators and moving walks should be well lit, with a minimum illuminance of 50 lux at the treads and 100 lux at the landings; the SLL recommends an illuminance of 150 lux. These lighting levels should be considered in relation to the illuminance of the surrounding spaces so that there are not abrupt changes, which can cause problems to people who cannot adjust to different lighting levels quickly.

Escalators

Lighting at right angles to the steps can help to define the treads and the risers, and will reduce glare.

Strip lighting set into the skirting helps to highlight the step edges and providing a visually contrasting line either side of the moving steps

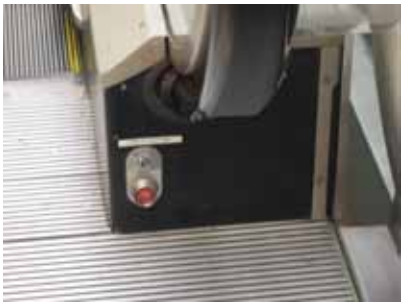
Rail stations

The European standard states that, where artificial lighting is used, the level should be 40 lux above the ambient surrounding light levels and have a colder colour temperature.

It is recommended that the lighting level over steps and stairs is increased to 150–200 lux, with a smooth transition.

4.5.18 Acoustics

Escalators and moving walks inevitably generate some noise and vibration. They should be located where they cause minimum disturbance, and structural elements of the building associated with them should not penetrate areas or rooms that are required to be quiet. Where the function of the building requires it (for example, schools, hospitals, libraries) the walls, floors and ceilings around the escalators and their machine rooms should be sound absorbent.



An emergency stop button on the front face of the skirting at the end of an escalator is not easily visible or accessible, whereas one placed above the handrail or on the area between two escalators is clearly visible and accessible.

4.5.19 Emergency switches

Emergency switches to stop an escalator or moving walk must be clearly visible, positioned so that they can be reached by all users, and usable by people with limited dexterity. They should not require much pressure (2.5–5 newtons) and it should be possible to use them with the palm of the hand. They should be red and marked 'STOP'.

If CCTV is used, the camera nearest to an emergency stop button should be interfaced to it via the building management system (BMS). This will immediately put a view of the incident in front of the control room operator rather than incurring a delay while a camera is sought.

Escalators

Emergency stop switches must not be more than 30m apart, and there must be one at each end of an escalator near the landings.

Moving walks

The emergency stop switches must not be more than 40m apart along the length of a moving walk.

Shopping centres

Where moving walks are used in shopping centres, the Health and Safety Executive (HSE) recommends that additional emergency switches are installed at exits 2m before and after the comb intersection line above handrail level. The one before the comb intersection line should be reachable from inside the moving walk; the one after the comb intersection line should be reachable outside the moving walk so that non-users can activate it if they see some people struggling to exit or any other potential emergency situation.

4.6 Escalators used as a means of escape

In some circumstances where it is not possible to provide escape stairs, such as underground stations, escalators are used as a means of escape as part of a predetermined emergency strategy. The main considerations are:

- protection to the escalator
- different operational modes during an emergency
- communication systems

If escalators are to be used in the event of a fire, protection should be provided to ensure that compartmentation is not compromised and that those using the escalator are protected from fire hazards. Depending on the type of building, this may comprise fire shutters, fire doors and/or a smoke control system.

Guidance on the use of escalators as a means of escape is covered in BD 2466: *Guidance on the emergency use of lifts or escalators for evacuation and fire and rescue service operations*.

4.6.1 Operational modes

There are three operational modes that can be employed in the event of an emergency evacuation:

- normal operation, with staff preventing people getting on escalators going in the opposite direction
- stopping escalators moving in the opposite direction to the escape and allowing them to be used as stairs, but this is not ideal as the risers vary in height and are steeper than normal stairs (see above). LUL specifies a maximum step rise of 210mm in this situation
- reversing the direction of escalators moving in the opposite direction to the escape, which will take time and more staff resources

4.6.2 Communications

A good communication system is required to alert both staff and public about the use of the escalators. Particular care and control are needed to avoid a crush at the discharge point of the escalator and it should be possible to stop the escalator both locally and from a central control room to prevent this.

4.7 Historic buildings

Steps and stairs in historic landscapes and buildings are likely to have architectural or historic significance, and it may not be appropriate or reasonable to change them to meet the current regulations and recommendations. Historic buildings are not exempt from making changes to improve access under the DDA, which requires reasonable changes to be made, but changes have to be balanced with the need to conserve the architectural and historic features of the building or landscape. Listed building consent will be needed for any alteration or extension that affects the fabric or character of a listed building, and it is advisable to seek the advice of a conservation architect, building conservation officer, historic building surveyor or local planning authority to assess what changes are likely to be acceptable. Any alterations and changes need to be very carefully implemented through a sensitive interpretation of the guidance incorporating and balancing human, environmental and conservation needs. The general maxim is that any alteration should be reversible and should not affect the fabric of the original building. If a building has already been altered in the past there may be greater scope for access improvements in these areas, which may be considered of less significance than original parts of the building.

4.7.1 Steps and stairs

Existing steps and stairs in an historic environment, particularly steps up to the main entrance or the main internal staircase, are likely to be an architectural feature or significant design elements, and there may not be an option to make major alterations. Therefore, alternative access needs to be considered, such as an alternative route, a ramp or lift, ideally for use by everyone, not just wheelchair users and those unable to negotiate steps and stairs. Where possible there should be a choice of routes and the alternative routes should be clearly signed.

A ramp has been sensitively added to this small garden to provide step-free access to an historic churchyard in this museum

Improvements that may be made to steps/stairs without physically altering them or materially changing their character or aesthetics include:

- adding contrasting nosings, which can be removed, for example removable paint – adhesive tape is generally not recommended, but may be the only possible solution
- installing lighting to create shadows to highlight the edge of the steps or stairs
- providing visual or tactile contrasts in surfacing that tie in with existing site materials to warn of hazard
- repairing worn or damaged steps
- providing handrails that do not compromise the aesthetics or dimensions of the steps or stairs, and which can be removed – on wider steps it may be possible to install a central handrail rather than a handrail on both sides
- indicating the steps on a tactile map or audio guide

External steps

Where there are steps up to the main entrance of a building, the options for step-free access are a different entrance at ground level, a ramp (see below) or a platform or stair lift.

There may be a case for an alternative inclusive main entrance at ground level for all visitors, thus preserving the feature stair and entrance without the clutter of ticketing, security and cloakrooms that accompanies a contemporary entrance. Vertical access can be addressed within the building, but, if this is not feasible, alternative accessible access should be clearly signed from the main approach route.

Historic areas are more sensitive to the colour and types of paving used and therefore it may not be appropriate to provide standard tactile hazard warning surfaces at the top and bottom of the steps, but it may be possible to provide some visual or textural contrast to provide a hazard warning. Many visually impaired people still have partial sight and can distinguish between contrasting shades, which helps them recognise where potential hazards exist.

Lifting steps in Germany provide step-free access to the main entrance of this museum without altering the fabric of the building and maintaining its external appearance

It is important to keep external steps, particularly if they are uneven, clear of algae, plants, leaves and loose gravel and to remove snow and ice, all of which will reduce their slip resistance and create potential slip and trip hazards (see **Section 5**).

Internal stairs

Internally, ideally a passenger lift should be installed to give access to upper and lower floors if space and conservation requirements permit. This may be possible if, for example, there are closets occurring in the same location on several floors. If it is not feasible to install a lift within the building it may be possible to provide an independent external lift accessed from each floor level. Where it is not possible to improve the main staircase in a building, it may be possible to improve a secondary staircase to closer meet the requirements and/or to install a platform or stair lift. Where it is proven impossible to provide step-free access to upper and lower floors, a 'virtual tour' by means of a video may be the only reasonable option.

These stairs are inside the entrance to a listed building. To provide wheelchair access, half the stairs slide away and a glazed barrier rises from the floor at the top. A section of the lower floor then rises as a platform lift. As the platform ascends the glass screen lowers into the floor, giving level access at the top. When the platform lift is not in use the central barrier and handrail can be removed to enable people transporting large items to use the stairs

Metal stairs with perforated treads, such as cast iron, often found in an historic building, may confuse visually impaired people, and an alternative should ideally be provided.

4.7.2 Ramps

External ramps

Existing external ramps or steep slopes may be difficult to change as they are likely to be a feature of the site. It may be possible to provide an alternative route that better meets current recommendations; alternatively, providing information on routes, resting places with seats, and powered scooters will all help to improve access for disabled people. Surfaces are also important: where possible, gravel and cobbled surfaces should be replaced with level, smooth surfaces.

Stepped ramps are not recommended as they are difficult for people with limited mobility and may be difficult for people with visual impairments. If they are unavoidable, tactile indicators on the handrails at each step may assist.

Where a ramp is added to the front or side of a building as an alternative to existing steps, its symmetry and scale should relate to the steps and the elevation of the building and materials and any detailing should be compatible. If not obvious, it should be clearly signed in words and graphics. Where an extreme level change would require a long, circuitous ramp or where space is limited, a short-rise lift may be appropriate either as an alternative or in addition to the ramp.

Curved ramps have been added to either side of the entrance steps to this historic office building, maintaining the symmetry and without compromising the appearance or fabric of the building. Although there are not handrails on both sides of the ramps, with the ramps either side of the central steps there is still a choice of left- or right-hand support

A simple solution to these wide, small-rise steps to the entrance of this historic building is a central slope dividing them, minimising the intervention and maintaining the symmetry

A ramp utilising the space to the side of these steps provides step-free access to the main entrance of this office building without intruding on the pavement

Internal ramps

Internal ramps are not normally existing features, but should, where possible, be provided to replace single steps. They are also often preferable to platform lifts for a short flight of stairs as they cater for more people but may be difficult to provide owing to space restrictions or damage to the fabric of building. In exceptional circumstances a ramp steeper than 1:12 over a short distance may be acceptable, although it will not be suitable for all wheelchair users and it is important that appropriate information is provided. In providing a new internal ramp, account must be taken of historic design features such as skirtings, plinths or dado rails, and the installation may need to be reversible.

This etched glass ramp has been installed over the area behind the existing railings to provide step-free access to the main entrance of this office building, while still allowing light into the basement area

The space between two existing historic buildings has been covered with a glazed roof to link them together and gently graded to avoid single steps

A recent refurbishment of this heritage property eliminated small changes in level where possible by altering floor levels. Where level changes could not be avoided, both steps and ramp were provided, which almost achieved inclusive design standards current at the time. The changes were effectively reversible without undue impact on the historic fabric

A glass sloping bridge providing a link between two upper areas of this museum has minimum impact on the appearance of the building and lets light through to the lower main circulation area

Temporary/portable ramps

In some cases a temporary or portable ramp (see above) may be the only solution to preserve the architectural features or fabric of the building, but care must be taken to ensure that their positioning does not create an additional trip hazard and that they are properly managed. Emergency egress will also need to be planned and managed to ensure the safety of all staff and visitors.

A portable ramp with upstand edges used in an historic building to overcome a single step

4.7.3 Handrails

Handrails are often a decorative and highly visible feature but are unlikely to meet the current standards in their profile or for extensions. It may not be acceptable to change them as new handrails conforming to the current standards would inevitably impact on the character of the existing spaces and features.

Although it does not meet all the recommendations, a second matching handrail may be the best solution in an historic environment

A simple additional handrail, fixed to the timber stairs, does not damage the decorative walls or this historic house and is easily removable

The central glass balustrade to this dogleg ramp provides support for the handrail and has minimum impact on the appearance of the building

Where there is a handrail on only one side of the stairs, it may be reasonable to match the existing handrail on the other side even if it does not fully comply with current standards. Another possible option is to add an additional handrail, providing it could be removed if necessary and the fixings do not damage the fabric of the building.

Building management 5

5.1 Cleaning

Regular cleaning of steps, stairs, ramps, escalators and moving walks is essential to ensure their safe use. Treads and ramp surfaces must be kept free from obstructions which could present a trip hazard. Litter and organic matter are likely to be a slip or trip hazard, and contamination from dust, dirt, water, oil or other liquids will affect the physical properties of the finishes, such as reducing slip resistance. For escalators and moving walks, cleaning will also help to maintain their safe and efficient operation. Effective cleaning with appropriate materials and equipment will also help to maintain the appearance and the durability of the finishes.

© Michael Woods, RSSB

These steps linking a major road to a busy interchange station, on the boundary of two boroughs, were not cleaned because the two rail organisations and the local authorities concerned could not agree whose responsibility it was. Because of the accumulated litter they were a potential slip and trip hazard. The situation was resolved following a photographic campaign from a local user and the steps are now cleaned regularly

The frequency of cleaning and maintenance should be determined by the number and type of users, and location. Most stairs will require daily cleaning, regular deep cleaning and potential repairs, and periodic redecoration. Internal stairs, ramps and escalators near to building entrances are likely to need more frequent cleaning.

The cleaning regime in terms of method, equipment and materials must be appropriate to the finishes. Manufacturers of flooring products generally provide instructions for cleaning and, similarly, cleaning materials provide guidance for their use and application; these should always be followed. Insufficient cleaning can lead to a build-up of debris and rubbish, which, in some situations, may create a fire hazard or, in the case of escalators and moving walkways, may become trapped in the machinery, causing resistance to movement and resulting in heat generation and potential failure. Cleaning using the wrong equipment or materials can irreversibly damage the finishes, reducing their performance and life expectancy, for example reducing the roughness of a surface and thus its slip resistance or changing the colour and reflectance of the surface. Poor cleaning can result in contaminants or cleaning materials (detergents, polish) remaining on the surfaces, which will similarly affect performance, appearance and durability.

Detergents used for cleaning should be as neutral as possible. Solvent cleaners and

alkaline or caustic detergents should be avoided if possible as they present a health and safety hazard to those using them and may damage some surfaces. If detergents are used, they must be rinsed off thoroughly with clean water so that no residue remains.

Nosings on steps and stairs are particularly vulnerable to both damage and wear due to cleaning, which could affect their potential for trips, slip resistance, reflectivity, colour and visual contrast, and great care should be taken to ensure that their integrity is retained.

© Alison Grant

This cracked nosing is a potential slip hazard

External steps and ramps need to be kept clear of moss and algae and will need extra cleaning at certain times of the year, to remove snow and ice in the winter, and pollen and leaves in the spring and autumn. Anti-icing fluids should be used with great care as they tend to leave a greasy film on the surface, creating a potential slip hazard. Any drainage holes must be kept clear to avoid ponding.

Great care must be taken that internal stairs and ramps are not left wet after cleaning if they are intended to be used, as this will affect their slip resistance, appearance and reflectivity. If possible, they should be cleaned to a completely dry finish; if this is not possible, barriers and signs should be used to warn users and preferably keep them off the wet areas or, where there is a significant risk of slipping, a member of the facilities management team should be present to warn and guide people away from the wet area as signs may not be adequate. Care must be taken that the barriers and sign do not themselves constitute an obstruction or trip hazard. Ideally, cleaning should take place at a quiet time, or an alternative route should be available.

If spillages or other accidental contamination occur, these must be either cleared up or reported to maintenance staff immediately.

Regular and effective cleaning should be a priority for building management. Cleaning frequency and regimes should be specified in the operation and maintenance manuals, but must also be managed to ensure that the requirements are understood by the staff responsible, correctly implemented and monitored, and reviewed and improved if necessary.

5.2 Inspection and maintenance

5.2.1 Steps, stairs and ramps

Inspection and maintenance are essential to ensure the safety, usability and appearance of steps, stairs and ramps. Poor maintenance can also result in people feeling less secure.

There should be a regular programme of inspection to check for damage and general wear and tear, followed by any necessary maintenance required to:

- retain the original appearance: colour, visual contrast, reflectivity
- retain the slip resistance of stair treads, ramps and landings
- retain the integrity of nosings: wear, slip resistance, visual contrast, reflectivity

- ensure that the nosings are securely fixed and flush so that they do not present a trip hazard
- check and replace loose handrail and balustrade fixings so that they provide adequate support for those that need to use them and in the event of a fall
- maintain lighting levels by replacing faulty or non-functioning lamps. A study relating to stairway falls and lighting showed that, when light levels were reduced from 86 lux to 22 lux, accident rates increased from 11 per cent to 22 per cent

Regular inspection and maintenance requirements should be included in the operation and maintenance manuals. All maintenance work should be carried out promptly and correctly, and replacement of surfaces, nosings, handrails and balustrades done as necessary.

5.2.2 Escalators and moving walks

The inspection and maintenance of escalators and moving walks comes under the Health and Safety at Work Regulations and PUWER. The requirements for the cleaning, inspection and maintenance of escalators and moving walks, and the records that must be kept, must be included in the instruction handbook relating to use, maintenance, inspection, periodic checks and rescue operations that must be provided with all installations. These instructions must be in accordance with EN ISO 12100-2 *Safety of machinery – Basic concepts, general principles for design – Part 2: Technical principles.* Further guidance is given in EN 13015:2001 *Maintenance for lifts and escalators. Rules for maintenance instructions*. Owners of a significant number of escalators and moving walks normally carry out a thorough inspection every 6 months. Escalators and moving walks require a major overhaul, lasting about 9 months, at least every 20 years.

Appendix: Sources of useful information

British Standards Institution (BSI)
389 Chiswick High Road
London W4 4AL
Tel: 020 8996 9000
Fax: 020 8996 7001
Email: cservices@bsi-global.com
Website: www.bsi.org.uk

Publishes British Standards.

Building Research Establishment (BRE)
Bucknalls Lane
Garston
Watford WD25 9XX
Tel: 01923 664000
Fax: 01923 664010
Email: enquiries@bre.co.uk
Website: www.bre.co.uk

BRE undertakes research and provides guidance on all aspects of construction.

Centre for Accessible Environments (CAE)
70 South Lambeth Road
London SW8 1RL
Tel/textphone: 020 7840 0125
Fax: 020 7840 5811
Email: info@cae.org.uk
Website: www.cae.org.uk

Provides technical information, training and consultancy on making buildings accessible to all users, including disabled and older people and carers of young children.

Chartered Institute of Building Service Engineers (CIBSE)
222 Balham High Road
London SW12 9BS
Tel: 020 8675 5211
Fax: 020 8675 5449
Email:
Website: www.cibse.org

UK-based institution for building services.

Construction Products Association
26 Store Street
London WC1E 7BT
Tel: 020 7323 3770
Fax: 020 7323 0307
Email: enquiries@constprod.org.uk
Website: www.constprod.org.uk

Trade association representing manufacturers and suppliers of construction products, components and fittings.

Department of Finance and Personnel (DFP)
Building Regulations Unit
Properties Division
10th Floor, River House
48 High Street
Belfast BT1 2AW
Tel: 028 9025 7326
Fax: 028 9051 8359
Email: info.bru@dfpni.gov.uk
Website: www.dfpni.gov.uk

For information on the Northern Ireland Technical Booklets.

Communities and Local Government (DCLG)
Eland House
Bressenden Place
London SW1E 5DU
Tel: 020 7944 4400
Fax: 020 7944 9645
Email: bregsb.br@communities.gsi.gov.uk
Website: www.communities.gsi.gov.uk

For information on the Building Regulations.

Equality and Human Rights Commission (EHRC)
3 More London
Riverside Tooley Street
London SE1 2RG
Tel: 020 3117 0235
Fax: 0207 407 7557
Email: info@equalityhumanrights.com
Website: www.equalityhumanrights.com

Promotes equality and human rights by providing advice and guidance, working to implement an effective legislative framework and raising awareness of people's rights. Also has offices in Glasgow, Cardiff and Manchester.

The Equality Commission for Northern Ireland
Equality House
7–9 Shaftesbury Square
Belfast BT2 7DP
Tel: 028 90 500600
Fax: 028 90 248687
Textphone: 028 90 500589
Email: information@equalityni.org

Works towards the elimination of discrimination and keeps the relevant legislation under review.

Health and Safety Executive (HSE)
Information Services
Caerphilly Park
Caerphilly CF83 3GG
Tel: 0845 345 0055
Fax: 0845 408 9566
Email: hse.infoline@natbrit.com
Website: www.hse.gov.uk

Government agency responsible for regulating, providing guidance and monitoring health and safety. See website for regional offices.

Royal Institute of British Architects (RIBA)
66 Portland Place
London W1B 1AD
Public information line: 0906 302 0400
Tel: 020 7580 5533
Fax: 020 7255 1541
Email: info@inst.riba.org
Website: www.architecture.com

The RIBA advances architecture by demonstrating benefit to society and excellence in the profession.

Scottish Building Standards Agency (SBSA)
Denholm House
Almondvale Business Park
Livingston
West Lothian EH54 6GA
Tel: 01506 600 400
Fax: 01506 600 401
Email: info@sbsa.gov.uk
Website: www.sbsa.gov.uk

For information on the Scottish Technical Handbooks.

Smithers Rapra Technology
Shawbury
Shrewsbury
Shropshire SY4 4NR
Tel: 01939 250383
Fax: 01939 251118
Email: info@rapra.net
Website: www.rapra.net

Contract consultancy, technical and commercial, specialising in rubber and plastics. Also home of the UK Slip Resistance Group.

Sport England
3rd Floor
Victoria House
Bloomsbury Square
London WC1B 4SE
Tel: 08458 508 508
Fax: 020 7383 5740
Email: info@sportengland.org
Website: www.sportengland.org

SportScotland
Caledonia House
South Gyle
Edinburgh EH12 9DQ
Tel: 0131 317 7200
Fax: 0131 317 7202
Email: library@sportscotland.org.uk
Website: www.sportscotland.org.uk

The Safety Assessment Federation
Unit 4, First Floor
70 South Lambeth Road,
Vauxhall
London SW8 1RL
Tel: 020 7582 3208
Fax: 020 7735 0286
Email: info@safed.co.uk
Website: www.safed.co.uk

The Stationery Office Limited
PO Box 29
Duke Street
Norwich NR3 1GN
Tel: 0870 600 5522
Fax: 0870 600 5533
Email: services@tso.co.uk
Online ordering: www.tso.co.uk/bookshop

Sells printed versions of any item of legislation or any other official publication previously published by HMSO.

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Approved Document K: *Protection from falling, collision and impact*, 1998 edition incorporating 2000 amendments
NBS, 2006

Approved Document M: *Access to and use of buildings*, 2004 edition
NBS, 2006

The Building Regulations (Northern Ireland) 2000

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Great Britain Department of Finance and Personnel (Northern Ireland) The Stationery Office, 2005

H: 2006 – *Stairs, ramps, guarding and protection from impact*
Great Britain Department of Finance and Personnel (Northern Ireland)
The Stationery Office, 2006

R: 2006 – *Access and use of buildings*
Great Britain Department of Finance and Personnel (Northern Ireland)
The Stationery Office, 2006

Building (Scotland) Regulations 2004

Non-domestic technical handbook,
2007, updated 2009
Scottish Executive
The Stationery Office, 2007

Construction (Design and Management) Regulations 2007

Health and Safety Executive, 2007

Managing health and safety in construction: Construction (Design and Management) Regulations 2007 (CDM) – Approved Code of Practice
Health and Safety Executive, 2007

Disability Discrimination Acts 1995 and 2005

Department of Work and Pensions

Statutory Instrument 1992 No. 3004, The Workplace (Health, Safety and Welfare) Regulations 1992

The Stationery Office, 1992

Statutory Instrument 1991 No. 1620, The Construction Products Regulations 1994

The Stationery Office, 1994

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Office for the Official Publications of the European Communities, 2008)

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BS 1134-1:1988 *Assessment of surface texture. Method and instrumentation*
British Standards Institution, 1988

BS 5395-1:2010 *Stairs, ladders and walks. Code of practice for the design, construction and maintenance of straight stairs and winders*
British Standards Institution, 2010

BS 5395-2:1984 *Stairs, ladders and walks. Code of practice for the design of helical and spiral stairs*
British Standards Institution, 1984

BS 5656-1:1997 *Safety rules for the construction and installation of escalators and passenger convoys. Specification and proformas for test and examination of new installations*
British Standards Institution, 1997

BS 5656-2:2004 *Escalator and moving walks. Safety rules for the construction and installation of escalators and moving walks. Code of practice for the selection, installation and location of new escalators and moving walks*
British Standards Institution, 2004

BS 6180:1999 *Code of practice for barriers in and around buildings*
British Standards Institution, 1999

BS 6399-1:1996 *Loading for buildings. Code of practice for dead and imposed loads*
British Standards Institution, 1996

BS 7000-6:2005 *Design management systems. Managing inclusive design*
British Standards Institution, 2005

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British Standards Institution, 2002

BS 7976-2:2002 *Pendulum testers. Method of operation*
British Standards Institution, 2002

BS 8233:1999 *Sound insulation and noise reduction for buildings. Code of practice*
British Standards Institution, 1999

BS 8300:2009 *Design of buildings and their approaches to meet the needs of disabled people. Code of practice*
British Standards Institution, 2009

BS 9999:2008 *Code of practice for fire safety in the design, management and use of buildings*
British Standards Institution, 2008

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British Standards Institution, 2008

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British Standards Institution, 2004

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International Organization for Standardization, 2003

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Department of Transport, 2008

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The Stationery Office, 2004

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Disability Rights Commission
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Index

C

D

E

F

G

H

I

L

S

T

V

W