EXTERNAL PEDESTRIAN PATH SURFACES

INTRODUCTION

Slips and trips account for fifty percent of all reported injuries to members of the public. People with impairment through age or disability are particularly prone to this type of accident. The elderly are also more likely to suffer serious injury than younger people.

Careful selection, construction and maintenance of path surfaces can have a significant impact on the number of falls that visitors and staff may experience. When choosing the most appropriate surface take account of how the path will be used, and also consider its setting, environment and the landscape.

When deciding what type of path surface and level of control is appropriate it may also be helpful to zone the areas of path in accordance with the VSCG risk control matrix. Paths provided for the public in "urban" zones, generally need to be able to be used safely by all people from the very young to the very old, some of whom may have limited hazard perception, various mobility or sensory impairments and unsuitable footwear. When selecting path surfaces in a more rural setting, it can be assumed that visitors will have a moderate level of fitness, and be better equipped. In wild or rugged terrain formal path surfacing may not be necessary.

RISK ASSESSMENT

Research has shown that a combination of factors contributes to pedestrian slip accidents:

- **Path material** – The slip resistance in both wet and dry conditions and surface roughness need to be considered along with durability, wear and maintenance requirements as well as cost and appearance.
- **Contamination** – For example algae or excrement from horses or pigeons can greatly increase the slip risk. Where it can not be easily prevented or controlled, contamination needs to be taken into account when selecting the surface material.
- **Environment** – Lighting, noise, visual distractions, slopes and changes in level and the consequences of falls should also be taken into account. Significant gradients need greater slip resistance; ramps need to be obvious, for example by using a contrasting colour to that of the landings.
- **Use** – The amount of control over the way in which the path will be used and by whom should also be considered. If people are carrying large bags or other objects then their chances of falling are increased. The elderly also have a much greater risk of slipping.
- **Behaviour** - Looking for signs, and using mobile phones or running can lead to hazards not being seen.
- **Footwear** – Good fitting flat shoes/boots with a well designed tread pattern minimise the risk of slipping. However, in many cases people using paths may not have appropriate footwear.

OPTIONS FOR CONTROL

When considering the options available to improve control of slip and trip hazards, as with all risk assessments, possible improvements should be subject to a careful cost benefit analysis. This will help you to decide what would be reasonably practicable, given the costs involved and the amount of risk reduction that would be achieved. Cost considerations should not just be financial. You should also take into account impacts on the natural or historic environment. The following matrix provides a guide as to what may be considered reasonable in a range of environments.

Wild Terrain	Rugged Terrain	Rural Terrain	Urban Terrain
No identifiable paths	Paths in place, but not constructed or surfaced to any standard	Paths constructed, but may be uneven and steep with some slip and trip hazards. only major hazards controlled	Where possible path surfaces to be even, and firm with good slip resistance
No information provided	No information provided	Routes identified, and advice given regarding safe use of paths	Information to be provided on easily accessible routes and those areas where access is more challenging
No maintenance	Inspection after major incidents such as storms to identify and rectify major hazards	Occasional inspection and maintenance	Frequent inspection, and maintenance

Stirling Castle, Scotland

High visitor numbers at the castle ensure that the paths are treated as urban terrain.

Mount Stewart, County Down, Northern Ireland

Mount Stewart gardens have been added to the list of potential World Heritage Sites. The surfaces are an integral part of Lady Londonderry's garden design. Therefore they would not be changed. Alternative pedestrian routes would be created if necessary.

Some factors can not easily be controlled. Risk controls need to focus on those elements which can easily be controlled. Areas over which path providers can have some influence are:

Slip resistance and roughness – All accessible path surfaces should be compact, firm, stable, and obstacle free. Surfaces should also be slip-resistant (i.e. have a Slip Resistance Value between 35 and 45) in wet and dry conditions and should not be made of reflective material. Suitable materials include concrete, bitumen macadam, stone, timber, brick/paving and grass. Sand, loose gravel, woodchips and cobbles should not be used.

Linlithgow Palace, **Scotland**

The surfacing of the courtyard is of little historic significance. Therefore it has been replaced with modern materials, including mesh over the drain gulley, to create safer access.

Uneven surfaces, can cause problems, the maximum deviation of the footway surface under a 1 metre straight edge should not exceed 3mm. Dished channels (for drainage) should not be incorporated within pedestrian routes.

Where contamination can not be avoided, profiled surfaces should be used, or aggregate mixed into the final adhesive layer to form a macro rough surface. It is important that the slip

resistance of surfaces is even. Patches as small as 75mm^2 with different slip characteristics are enough to allow a slip.

Crossfall on footpaths may be necessary to provide good drainage, but if too great, can make it difficult for wheelchair users. Any crossfall should, where possible, be between 1 and 2 in 100. Variable crossfall affects the steering of wheelchair users and can also cause problems for people with walking difficulties.

The characteristics of different surfaces are discussed later.

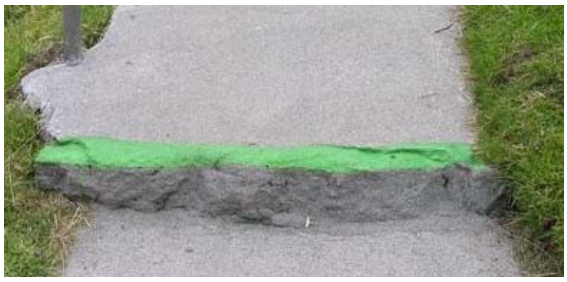
Visual indicators – Many accidents are caused by unexpected changes in the walking surface. People do not often consciously recognise changes, so using signs or other forms of warning that make changes more easily recognisable can reduce the number of falls. For example, it is possible for most people to safely walk on icy or slippery surfaces if the hazard is perceived and the pedestrian alters their behaviour accordingly. Information can also be provided at the start of paths and trails highlighting dangers and advising walkers of precautions they may wish to consider.

Gradients and steps – Where reasonably practicable, especially in urban terrain, level access should be provided, but often the natural landscape has gradients. Sloping surfaces also drain better.

Slopes greater than 1 in 20 are regarded as ramps, and should be of a colour contrasting with that of the landings, of a material with good slip resistance and, where practicable, fitted with a handrail if they are used by the less able. As ramps can become dangerous when exposed to wet and other adverse weather conditions steps should also be provided as an alternative where possible.

Peveril Castle, Castleton, Derbyshire

The edges of the steps have been painted to make the change more obvious to people walking down the path.



Lighting – Most paths will be outside and rely on natural light, but where paths connect with indoor areas or are used after dark care should be taken to ensure that there are no sudden contrasts between brightly lit areas or bright sunlight and dimply lit, shaded or unlit areas.

TYPES OF SURFACE

This section gives examples of formal types of path surface that may be used in a variety of settings.

Clay and Brick Paving – This has good slip resistance in both wet and dry conditions. However, gaps between paving slabs can cause problems for people using sticks and crutches, visually impaired cane users and wheelchair users. Joints between flags and pavers should not be less than 2mm and not more than 5mm wide.

On pedestrian-only footways, flags can be laid with wider joints (6-10mm) filled with compacted mortar. When small paving bricks (paviours) are used, care should be taken to ensure that they are evenly laid; unevenness can cause problems for wheelchair users and some visually impaired cane users.

Studley Royal, Fountains Abbey, Yorkshire

Cobblestones can be uneven and become slippery when wet. (Handrails may be necessary.) New cobbled surfaces are unlikely to be appropriate.

All sealed surface paths including paving, concrete and asphaltic/bitumous surfaces mentioned below require either a camber or cross-fall for drainage purposes. These should not exceed 2.5 per cent (1 in 40) and should not be less than 1 percent.

Stone Paving – Stone is a natural material and so can have variable properties. Surface finish has a significant effect on the slipperiness. Course textured or riven slabs should be used externally to give satisfactory slip resistance when wet. However the riven undulating surfaces are often relatively smooth, and so can be slippery. Gaps between stone flags or setts should be as described above for clay and brick paving.

The old, original flagstones shown opposite have been re-laid to create a level surface.

Concrete – Concrete surfaces are slippery when wet unless a textured finish is applied or a slip resistant aggregate is used. Contaminants may be absorbed into the surface, and in damp shady conditions algae will quickly form which will make the surface slippery.

The original concrete bridge, shown opposite, is in **Mount Stewart, County Down, Northern Ireland.**
The raised horizontal bars provide grip when the bridge is wet, but may, themselves, present a trip hazard.

Asphaltic and Bitumous surfaces – These provide a seamless path that is hard, durable, easily maintained and not inherently slippery. The surface roughens over time, but can become slippery if contaminated with oil and other petroleum products.

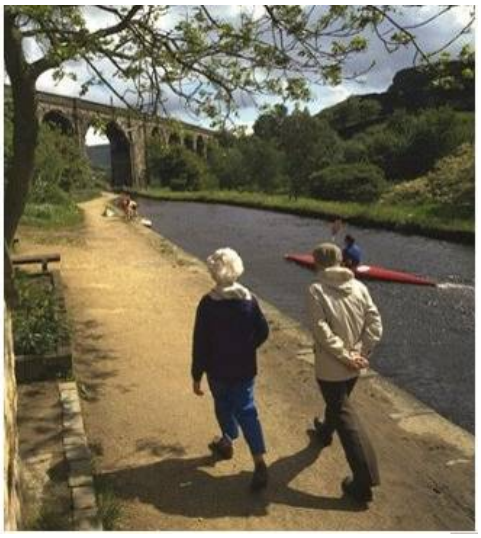
Aggregate – Whin dust is a commonly used surfacing. It is cheap, can be applied manually and provides an informal surface which can be used in many different areas. It is not suited to heavy use and is subject to surface water erosion and therefore requires a good drainage system. It is suitable for wheelchair use only if it is well compacted and maintained.

The best aggregate paths comprise layers, or grades, of angular, interlocking stone laid in a path tray. Building a path in several layers of differing grades of aggregate will significantly increase the path durability, firmness and stability, compared to using ungraded material in one, single layer.

- sub-base - the load bearing path foundation, required for deep construction over wet or rough ground
- base - provides strength to the construction and a solid base for the path walking surface
- surfacing - forms a durable, and firm surface over the path base
- binding - protects and prevents movement of loose surface material; provides a good walking surface

Each construction layer should contain a range of stone sizes. This ensures that the aggregate interlocks when compacted, to form a strong and solid layer without any gaps which may weaken the construction.

The construction layers are compacted to form a free draining camber, or cross-fall, for surface water to run off either one or both path sides, depending on the site. Drainage features should be incorporated in the path to prevent erosion, or possible destruction, of the path surface.



Huddersfield Canal Towpath

Limestone aggregate provides an appropriate surface for walkers and cyclists.

Aggregate paths are generally used on gradients below 8°. Higher gradients should be avoided as the aggregate will be more susceptible to migration down the path, from the pressure of feet, water flow, and gravity. The extent of migration also depends on the nature of the surface binding material. For instance granite derived aggregate does not bind well and will be mobile on gradients greater than 5°. On steeper slopes aggregate may be used if anchor bars are incorporated in the construction, particularly if the binding material is good.

Over wet and peaty areas the aggregate path may need to be floated on a geotextile base.

Different types of aggregate have different properties, and the best aggregate needs to be carefully selected considering all factors. For example, in environmentally sensitive areas grit stone may be most suitable as it is neutral and does not affect the acidity or alkalinity of the land. It does, however, take longer to solidify into a firm path surface.

A simple aggregate path, as shown opposite, can be useful. Here it was introduced in response to desire lines creating slippery tracks over grass leading from a car park.

Grass – Grass can be slippery when wet; but for paths with little or no gradient, and where light levels are sufficient, and trampling pressure is fairly low, grass makes an attractive path surface, which should be durable on free draining soil.

Grass on wet ground rapidly gets cut up by trampling and quickly becomes muddy. Once grass is established, regular mowing will encourage the development of a close turf. The mown width should be at least 1.8 metres to spread the trampling pressure and allow mowing by mini-tractor or other vehicle. Grazing by rabbits or deer, together with the trampling of walkers, may be sufficient to maintain a short grass sward. However, this needs regular

checking, because once the grass becomes too tall for comfortable walking, trampling will be limited to the centre of the path, which will then be reduced to bare earth and mud.

Reinforced turf made from specially selected grass grown on a geo-membrane laid over a prepared bedding layer and sub-base provides a strong stable surface that is suitable for most low traffic applications. This system ensures 100 per cent grass coverage, but the usual maintenance, such as feeding and mowing, will need to be undertaken on a regular basis.

In some locations, paths or tracks of crushed stone or gravel will eventually vegetate over naturally with a mixture of grasses, which helps bind the surface together.

Cellular Paving – Made of pre cast concrete or plastic, they are a cheap and unobtrusive way of providing a grass surface. The grass jointing is essential to the structural integrity of such systems. Where grass growth is absent or poor, the individual blocks have a lowered resistance to differential movement when trafficked. This can result in sub-base pumping via the gaps between the individual units. Firm edge restraint is essential as any rooting through to the sub-base will be tenuous at best and the units will spread under load. Castellated or studded systems can be difficult for pedestrians as the soil fill within the units settles or is washed from the surface, leaving a protruding 'stud' which presents a significant trip hazard.

Moulded plastic systems are only really suitable for occasional use. The relatively thin depth of these systems and their inherent flexibility can result in 'trampolining', where the units 'bounce' when trafficked. This can turn the surface into a quagmire in regularly trafficked areas. The trade-off for a higher ratio of grass cover is a reduction in tolerance to wear and loading. They should not be used on gradients where slip resistance is essential. However they can be used with gravels to stabilise a gravelled area, making it much more user-friendly to both pedestrians and vehicular traffic, as well as reducing scatter and drift, problems.

Timber Decking – On boardwalks with timber decking, boards should be laid at right angles to the direction of pedestrian flow. For boardwalks used by disabled people there should be a maximum gap between boards of 12mm. A larger gap of up to 25 or 30mm can be used on those installed in more remote and inaccessible locations.

Free drainage is important, otherwise frost and algae growth can make timber decking slippery in wet conditions. This can be reduced by regular applications of

water based wood preservative and good ventilation around the boards. However slip resistant strips may still be necessary, especially where they are used on a gradient. Strips should be placed so that every footfall lands on at least one strip. A non-slip surface can also be provided by epoxy tar sprays spread with grit.

Grooving the decking boards prior to installation can improve grip. Galvanised rabbit netting or plastic mesh can also be stapled to the boards to improve the level of grip. However care should be exercised in the use of this technique. Over time, holes often develop and therefore regular inspection and maintenance is essential to avoid creating trip hazards. Mesh can also sometimes make the boardwalk more slippery when wet and be dangerous in icy conditions.

Gratings – made of steel, stainless steel, aluminium or GRP should use anti slip grit based coating. Covers and gratings can cause problems and may be mistaken by blind people as a tactile surface. It is recommended that the maximum size of openings should be 13mm and if openings are elongated they should be placed at right angles to the predominant direction of travel. It is also recommended that the spaces should not be more than 150mm long. Wherever possible gully covers and drainage slots should be positioned as far as possible from main pedestrian flows. Inspection chamber covers and service inspection chambers should be flush with the surface.

Sykehouse Lock, New Junction Canal, West Yorkshire

Grating used to cover lock operating equipment.

MAINTENANCE

Poorly maintained surfaces can greatly increase the risks of slips and trips. Uneven wear may change the slip resistance characteristics of a surface over time. Surfaces need to be well drained and maintained in a good state of repair. Leaves mud and algae growth need to be regularly removed, and effective procedures to deal with snow and ice introduced.

LEGISLATION AND GUIDANCE

Health and Safety at Work Act 1974 – Requires that safe access and egress be maintained to places of work, and that a safe working environment be provided so far as is reasonably practicable. Also requires employers to conduct their undertaking so as not to expose visitors to risks to their health or safety, so far as is reasonably practicable.

Management of Health and Safety at Work Regulations 1999 – Require employers to assess and control risks to their staff and others who could be affected by their activities such as visitors.

Workplace Health Safety and Welfare Regulations 1992 – Require workplaces to have suitable traffic routes, well drained, free of obstructions and contamination, no holes, slopes, unevenness or slipperiness that presents a hazard.

Construction Design and Management Regulations 2007 – Require designers to consider the hazards during construction, use and maintenance of any path or surface they are making or altering.

Building Regulations (England and Wales) – Require that reasonable access be provided, level access where possible, undulations not exceeding 3mm over a 1 metre stretch (for formless materials) – different materials must have similar frictional characteristics. Building Regulations do not however apply retrospectively to existing structures, and will not apply to countryside paths.

REFERENCES AND FURTHER READING

Safer Surfaces to Walk On, *CIRIA* !Please note this is a large (22MB) file!

Access in the Countryside, Inclusive Mobility: A Guide to Best Practice on Access to. Pedestrian and Transport Infrastructure, DfT 2002

Easy Access to Historic Landscapes English Heritage

Woodlands, BTCV Handbook

Footpaths, BTCV Handbook

Upland Path work Construction Standards for Scotland, SNH

Lowland path construction – A guide to good practice, Paths for All

Countryside for all Good Practice Guide, Fieldfare Trust