



Footway maintenance management

Prepared for Pavement Engineering Group, Highways Agency

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Executive Summary

The report is a record of research carried out within a project, commissioned by the Highways Agency, to investigate current maintenance practices and put forward proposals for best practice for the consideration of Highway Authorities. The findings have been used in the newly published 'Delivering Best Value in Highway Maintenance – Code of Practice for Maintenance Management' (The Institution of Highways and Transportation 2001). The overall objective of the footways maintenance research programme is to establish criteria for assessing required investment in the footway network in order to improve serviceability levels for all users, to preserve the footway asset at best value and to assist in the mitigation of any future third party claims.

The proposals of the report are purely advisory and are not representative of Highway Agency policy. They have no prescriptive values and cannot be used to define liability in any way.

At present, Highway Authorities maintain their footways, making decisions on the basis of engineering and aesthetic criteria subject to accepted practices, to ensure that they remain safe for pedestrians and maintain their asset value. Furthermore, to support the Government's proposals for integrated transport and to encourage walking, it is necessary to take greater account of the needs of pedestrians, and ensure that they are satisfied with the safety and serviceability of footways.

Increased maintenance resources and/or a more effective use of existing resources are needed if the condition of the national footway network is to be improved and the walking environment made safer, and generally more acceptable. Moreover, many Highway Authorities need increased resources just to maintain footways to current criteria, rather than improve standards.

This report reviews and investigates current threshold levels with the aim of establishing realistic levels for maintenance investigation. These cannot be viewed in isolation from other aspects of the maintenance system that each Highway Authority has in place. Therefore, the report also examines the overall maintenance management system, and the necessary procedures for inspection, assessment, prioritisation and selection of treatment. The proposed thresholds and associated aspects of the maintenance system are intended for guidance only and do not form the platform for any national levels or liability defence. Furthermore, only surface defects are considered, i.e. those that are dealt with in the current inspection categories and highways maintenance programme.

The objectives of footway maintenance are safety, planned maintenance to prevent deterioration, and the provision of a satisfactory surface quality to encourage walking. When funds are lacking for planned maintenance, the resulting deterioration can cause an increase in the number of hazardous defects and potential for compensation payments, a poor walking surface and ultimately, more expensive reconstruction to restore

acceptable conditions. The benefits of timely maintenance are illustrated by idealised deterioration curves. However, unlike carriageways, which are damaged mainly by wheel loading, footway deterioration is mostly as a result of ageing, except where damage is caused by utility works or vehicle overrun.

A staged process of prioritisation is suggested, which optimises resources available for inspection and planning, concentrating on schemes most likely to be selected. It will provide a basis to prioritise funds and identify any need for increased funding. Individual Highway Authorities will be able to select defects and associated threshold values appropriate to their own networks, although any variations from published standards will have to be fully justified and documented.

Three different threshold levels are proposed to cover safety, maintenance and serviceability. Proposed threshold levels are based on a study of current standards and other available literature.

The legal background to safety threshold levels is reviewed. Safety threshold levels, inspection intervals and response times are proposed. Maintenance investigatory thresholds, treatment threshold levels and serviceability threshold levels are suggested for use with the staged inspection and prioritisation process. However it is recognised that increased and sustained maintenance expenditure will be necessary to achieve these standards.

The Footway Maintenance Working Group, whose members are drawn from government departments, a range of Highway Authorities and consultants, provided guidance on the research.

Footway Maintenance Working Group members:

- Mr P E Dickinson - Leeds City Council (Chairman).
- Mr P L Scott - TRL (Project Manager and Secretary).
- Mr T Clark - City of Edinburgh Council.
- Mr W Duerden - Department of Transport Local Government and the Regions.
- Mr K Fuller - Hampshire County Council.
- Mr L G Hawker - Highways Agency.
- Dr A Murray - Department for Regional Development (Northern Ireland) Road Service.
- Mr L Kaderbhai - Rhonda Cynon Taff County Borough Council (Wales).
- Mr D I Pearson - Consultant.
- Mr A Pickett - Chris Britton Consultancy.
- Mr G Prangnell - London Borough of Hammersmith and Fulham.
- Mr C C Spong - W S Atkins.

1 Introduction

1.1 Background

Highway Authorities currently maintain their footways, making decisions on the basis of engineering and aesthetic criteria subject to accepted practices, to ensure that the footways remain safe and their value as an asset is maintained. Furthermore, to support the Government's proposals for integrated transport and to encourage walking, it is necessary to take greater account of the views of pedestrians, to ensure that they are satisfied with the safety and serviceability of footways. The overall objective of the footways maintenance research programme is to establish criteria for assessing investment need in the footway network in order to improve serviceability levels for all users, to preserve the footway asset at best value and to assist in the mitigation of any future third party claims. In recent years there has been considerable emphasis on encouraging walking as a means of sustainable transport. See for example:

Encouraging walking – Advice to local authorities (Department of the Environment, Transport and the Regions, 2000 (a)),

Advice on a strategy for walking in London (London Planning Advisory Committee, 1997),

Walking – making it happen (London Walking Forum, 2000),

Guidelines for providing journeys on foot (Institution of Highways and Transportation, 2000).

There is increasing interest in urban regeneration and recognition of the importance of the 'street' in the urban environment:

Towards an urban renaissance (Urban Task Force, 1999),

Designing streets for people (Institution of Civil Engineers, 2000),

Streets for all – a guide to the management of London's streets (English Heritage, 2000).

Some of the factors, which it is generally agreed will encourage walking, include the setting of higher standards for footway design and maintenance and the use of quality audits. Key walking routes should be identified (the 'network approach'), and locations recognised where facilities need improvement to ensure network continuity.

The quality of access by foot to key destinations, such as rail stations and main bus stops should be audited (the 'walking catchment approach'). Local areas where pedestrians are to be given high priority should be identified.

The pedestrian environment should be improved by encouraging good quality urban design that can be consistently and easily maintained at reasonable cost. Trials should be carried out by selecting and developing demonstration projects.

The needs of people with some form of mobility impairment should be provided for and there should be continuity and consistency of provision with respect to signing, ambience and safety perception.

Personal security issues in pedestrian journeys have been addressed by the DETR (2000a). With regard to the footway surface itself, Leake *et al.* (1991) attempted to define the pedestrians' preferences. By relating attitudes to objective measures, possible thresholds for maintenance were identified.

The setting of inspection frequency cannot be considered in isolation from defect thresholds and response times since these determine the length of time defects of a particular size remain un-repaired. It is necessary to optimise whole life cost in relation to risk.

Against this background there has been insufficient expenditure to maintain footways in a desirable condition. The trend since the mid 1990s, according to the National Road Maintenance Condition Survey (NRMCS), is an increasing proportion of footways subject to general deterioration for all road classes, (Department of the Environment, Transport and the Regions, 2000b). However, the government's 10-year plan for England and Wales includes arresting and reversing this deterioration (Department of the Environment, Transport and the Regions, 2000c).

Most Highway Authorities will have systems in place for discharging their duty to take reasonable measures to ensure the safety of the user and maintain the highway. For local authority roads, most Highway Authorities followed guidance in the *Highway Maintenance – A code of Good Practice*, known as the *old LAA Code* (Local Authority Associations, 1989). An unpublished TRL survey of Local Authorities in 1996, with around 30% response, showed that about 55% of authorities complied with the old LAA code, but were not able to meet its requirements, while a further 25% comply and meet the requirements. For trunk roads, Highway Authorities must comply with the requirements set out in the *Trunk Road Maintenance Manual*, Highways Agency (1996, and subsequent revisions).

A new code of practice *Delivering Best Value in Highway Maintenance – Code of Practice for Maintenance Management* (DBVHM, IHT, 2001) is being introduced that will provide guidelines and set the minimum standards consistent with best practice and best value. This report provides background advice to the new code that will enable Highway Authorities to achieve even better standards. It sets out current best practice and it is hoped that all Highway Authorities will achieve or exceed this within five years, as local conditions and resources allow.

However, the thresholds and associated aspects of the maintenance system proposed in this report are for guidance only and do not form the platform for any national levels or liability defence. Highway Authorities are free to develop their own policies to suit their own conditions. The proposed framework is intended to supplement this and be in accord with currently planned maintenance management systems, e.g. UKPMS (1998/99).

Surface defects only are considered, i.e. those that are dealt with in the current inspection categories and highways maintenance programme. There are many other factors that influence safety and attitudes to walking, but are not currently covered by UK footway maintenance systems. These include: lighting; cleansing; snow and ice

on the surface (winter maintenance); horticultural maintenance; provision deficits, e.g. footway too narrow or lack of shelters; enforcement of legislation, e.g. cars parked on footway; and adjacent traffic issues. These are not considered in this report.

1.2 Research objectives

Earlier TRL research (Zohrabi *et al.* (2001) defined a hierarchy of pedestrian routes for prioritisation of resources and categorised over 60 defects in two groups. These are user related surface defects (serviceability) which fit into the current inspection categories and highway maintenance programme, and personal security, user satisfaction and comfort related defects (non-surface related). Condition Indicators were formulated to produce a measure of the relative condition of footways.

This report reviews current threshold levels with the aim of establishing realistic values for maintenance investigation and treatment. These cannot be viewed in isolation from other aspects of the maintenance system that each Highway Authority will have in place. Therefore, the report also examines the overall maintenance system and the necessary procedures for inspection, assessment, prioritisation and selection of treatment.

1.3 Methodology

A series of three Focus Group meetings were held in Northern Ireland, Northern England and Southern England. The main aim was to provide guidance for this footway maintenance research project by asking a range of practitioners for their views on provisional ideas on suggested maintenance system proposals. An identical format was adopted for all three meetings where the following five key topics were discussed:

- Inspection frequencies.
- Intervention levels.
- Response times.
- Serviceability.
- Whole-life costs.

Previous TRL studies are built on by reviewing existing guidelines and codes of practice. Threshold levels are developed taking account of currently accepted values in existing codes of practice and guidance from the Focus Groups meetings, the Footway Maintenance Working Group and other practitioners.

1.4 Structure of report

Section 2 sets out the objectives of footway maintenance and introduces a strategy for planned maintenance. Maintenance systems are introduced and new arrangements proposed in Section 3. In Section 4, the concept of setting investigatory levels for Safety, Maintenance and Serviceability is proposed. Section 5 provides background to safety threshold levels and Sections 6, 7 and 8 contain the proposed threshold levels for safety, maintenance and serviceability. Section 9 discusses other issues, such as inspection methods. Section

10 provides a summary of conclusions and invites consultation and comment on the proposed thresholds.

Current codes and threshold levels in use in the UK are compared in Appendix A of the report.

2 Footway maintenance strategy

2.1 Maintenance objectives

The objectives of footway maintenance may be summarised as:

- *Safety of the walking public.* The aim is to contribute to user safety, but this is also a statutory duty under the Highways Act 1980 and certain aspects of common law, (see section 5.1). In essence a Highway Authority's defence is its inspection and repair policy.
- *Maintenance of asset value.* The aim is to sustain the footway in a safe and usable condition whilst obtaining best value for money (Atkinson, 1997). The effectiveness of maintenance is normally improved if action is taken before major deterioration takes place. This requires a programme of planned maintenance to be in place at all times.
- *Serviceability.* In recent years much emphasis has been made of walking as a sustainable form of travel. One aspect of encouraging walking is to provide a walking surface of satisfactory quality, which, in practice, means comfort for all pedestrians and improving appearance.

Although it is helpful to distinguish between these objectives, they are not necessarily achieved in isolation from each other. Lack of planned maintenance results in a cycle of deterioration that includes:

- An increase in the number of hazardous defects.
- Reactive and often temporary repairs, such as patching, filling potholes and ramping trips, are less efficient than planned maintenance, see Footnote¹.
- Compensation payments result from successful claims arising from un-repaired defects.
- Resources are diverted from planned maintenance,
- The cumulative effect of patching may weaken the surrounding footway structure.
- Patching and local repairs add to the generally unkempt appearance of footways. There is a recognition that users need to experience continuity and consistency of provision, e.g. with respect to signing, ambience and safety perception.

¹ The Annual Local Authority Road Maintenance (ALARM) Survey (Asphalt Industry Alliance, 2001) estimates, for carriageways, that reactive maintenance costs ten times more than implementing a planned maintenance programme. The survey, which is based on a response to a questionnaire by 44 per cent of local authorities with highway maintenance responsibilities in England, Scotland and Wales, also indicates that about a third of available funds for carriageway maintenance is spent on reactive maintenance. Also the Roads Service in Northern Ireland spends about 30% of its structural maintenance budget for this purpose, but aims to reduce this to 10% (Northern Ireland Audit Office, 2000).

- Restricted budgets might result in a cheaper but less effective form of maintenance substituted for the preferred option, for example surface dressing as holding repair.
- Ultimately more costly repairs or reconstruction are required to restore conditions, see Footnote¹.

Conversely an adequate programme of planned maintenance should result in a progressive improvement in conditions and fewer claims. A further benefit of planned maintenance is that comfort for pedestrians is improved, without necessarily taking specific measures to improve serviceability.

2.2 Deterioration

In contrast with carriageways, which are principally damaged by wheel loading, footways are mostly affected by ageing, except where damage is caused in some way by utility works or vehicle overrun. Causes of defects and resulting distress modes are summarised in Table 1 and Table 2, and further details may be found in the Footways Design and Maintenance Guide Part 2 (TRL, 1997).

In general terms, small defects such as potholes may be the result of localised:

- Deficiencies in the structure, such as cracks, poorly compacted material or foundation defect, inadequate construction, or simply old age.

- Settlement in a utility excavation.
- Failure of an earlier or temporary repair.
- Failure of surfacing or overlay.

There has recently been a significant increase in utility openings in footways and Highway Authorities frequently feel that the Utilities do not always fully comply with the Code of Practice. Utility trenches and reinstatements frequently result in a consequential weakening and reduction in the life of a footway. The resulting patchwork of trench reinstatements and variability of hand-laid surface reinstatements are often criticised by pedestrians; appearance and relative smoothness are both important, particularly to the elderly and parents with prams. Frequently, the resulting reinstatement allows minor trips and depressions that hold water of up to 10mm (standards of reinstatement are set out in a Code of Practice (Department of Transport *et al.*, 1992, see Table A12 in Appendix A). Ideally there should be a better standard of reinstatement from the footway users point of view, as well as potential users, and many Authorities have expressed the wish that any trench opening should entail a full footway width resurfacing. Use of the present Code of Practice leads to a plane of weakness at the edge of trenches, which passes through to the surface. The existing pavement construction is undermined in the process and is frequently not corrected. Using the previous methods that

Table 1 Causes of general deterioration

<i>Cause of deterioration</i>	<i>Features</i>
Weathering/ageing	Ageing leads to hardening and embrittlement of bitumen. Freeze/thaw cycles cause surface deterioration. Clay shrinkage or swelling causes ground movement. Water ingress through cracked surfaces leads to weakening of foundations.
Utility openings	Utility openings in bituminous materials result in loss of structural integrity of the pavement. Poor trench reinstatement leads to settlement or unevenness, weakening of the structure, loss of interlock on modular surfaces.
Abuse	Vehicle overrun leads to foundation and structural failure.
Poor specification and design	Inadequate thickness, edge restraint, drainage or frost protection. Effect of changes in usage should also be considered, e.g. a footway designed to be an access that then becomes a main way to a shopping centre.
Faulty construction	Incorrect materials or methods leading to inadequate layer thickness, poor surface regularity or inadequate compaction.
Damage by vegetation	Weeds and tree roots cause surface unevenness.
Fair wear and tear	Heavy usage causes loss of surface texture and fretting. Slippery surfaces
User perceived failure	Spalling, cracking, poorly matched materials, patching etc. lead to an unacceptable appearance.

Table 2 Typical defects

<i>All types</i>	<i>Flexible</i>	<i>Modular</i>	<i>Concrete</i>	<i>Kerbs and edging</i>
Depressions and bumps	Excess binder	Broken or damaged modules	Cracking	Broken or missing items
Rutting	Mosaic cracking	Loss of jointing material	Damaged joints	Horizontal or vertical steps
Slippery surface	Linear cracking	Missing modules	Surface damage	Poor alignment
Surface contamination	Loss of surface aggregate	Rocking modules		Spalling of arris or face
Vegetation	Potholes	Spalling of arris or surface		Vegetation
Water		Trips		
		Unzipping		
		Widening of joints		

employed stepped reinstatements and surfacing layers, interrupting the present single vertical plane of weakness, would obviate these potential problems.

2.3 Deterioration curves

It is not possible to define a deterioration curve for footways; they do not decay at a rate proportional to the traffic loading, as is the case with carriageways. However, it is very useful to examine footway life by using an idealised deterioration curve concept. All defects requiring maintenance will require some action of the following type, depending on the nature and extent of the defects:

- 1 Localised repair, patching or pothole repairs, slab replacement, crack sealing etc. of non-dangerous defects.
- 2 Resurfacing, slurry sealing, inlay or overlay on sound foundations. Recycling methods may be used.
- 3 Reconstruction, full-scale replacement where the surface and foundation have failed, or partial reconstruction where localised failure has taken place. Again, recycling is an option.

This maintenance is illustrated in Figure 1 which shows the typical life cycle of a footway on an idealised deterioration curve, with the maintenance investigatory levels being reached in a logical sequence of: local repair (1), resurfacing (2) and reconstruction (3).

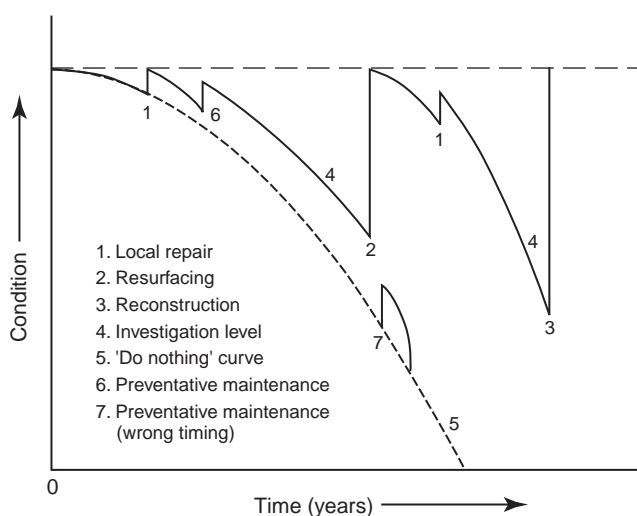


Figure 1 Typical deterioration curves

Efficient planning and prioritisation requires anticipation of future requirements. The maintenance *investigation* level (4) is when consideration must be given to some form of maintenance in a future programme that could be several years away. This would require knowledge of the deterioration curves for a range of types of construction, but in practice a decision may be to continue to monitor the position until corrective action becomes necessary.

An issue during prioritisation is that even when some footways have deteriorated significantly, it may be more cost effective to carry out preventative maintenance on footways in better condition, despite a natural reluctance to disregard poor conditions. This is the distinction between *worst first* and *economic* prioritisation.

If no maintenance action is taken, then the condition will deteriorate along the do-nothing curve (5) of Figure 1. In some cases little-used rural footways are allowed to completely disintegrate, thus reverting to a form of unmade surface. However, timely localised repair (1) and sealing or resurfacing (2) arrests this deterioration and prolongs the footway life delaying the requirement for more expensive options such as reconstruction (3).

2.4 Preventative maintenance

A parallel can be drawn of the importance of preventative maintenance as a strategy for carriageways as discussed by Zaniewski and Mamlouk (1999) and shown in Figure 2. When applied to a pavement in good condition, it extends its life by sealing the surface and preventing oxidation (preventative maintenance). Applied to a partly deteriorated pavement, it improves quality, but since the pavement is damaged it does not fully restore condition (corrective maintenance), see Figure 3. When applied to a fully deteriorated pavement it only provides temporary improvement (emergency maintenance). The authors are not yet able to define the level of distress when preventative treatment should be applied, but provide a number of examples of cost effectiveness of a programme of preventative maintenance compared with reconstruction. Although the concepts are applied to road carriageway pavements, they can be considered to be equally appropriate to footways.

3 Footway maintenance management systems

3.1 Introduction

For both engineering and legal reasons a Highway Authority should develop a systematic approach to meet its objectives. An integrated maintenance management system would include inspection, data collection and records, repair arrangements and records, monitoring of utility works, prioritisation of maintenance and customer contact arrangements. Risk management reviews indicate that improving systems and methods should come first, which will improve efficiency and ultimately contribute to user safety.

There needs to be a balance between carrying out whole-scale reactive maintenance and repairs, and corrective and preventative maintenance. When preventative maintenance is employed as a planned maintenance operation, the knock on effects and benefits are that reactive repairs and claims are reduced and more substantial maintenance is reduced and deferred.

Reactive maintenance can be costly in the provision of labour if it is of a random nature and cannot be efficiently planned.

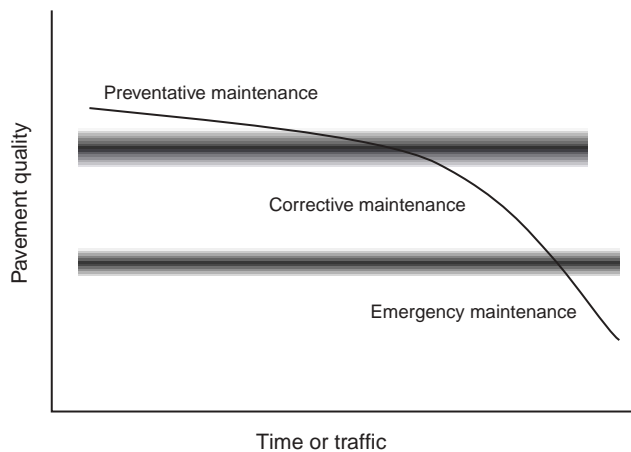


Figure 2 Conceptual performance of preventative maintenance treatments (from Zaniewski and Mamlouk, 1999)

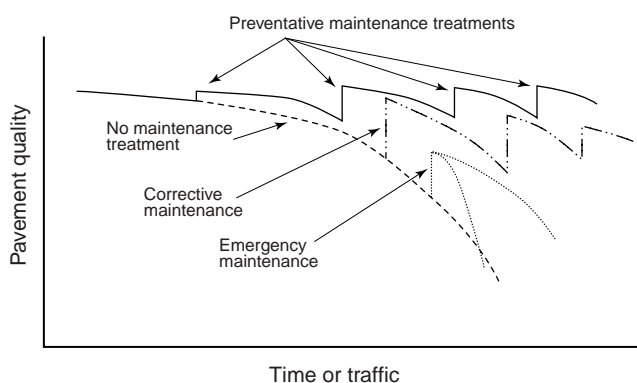


Figure 3 Performance of maintenance treatments applied to pavements with different conditions (from Zaniewski and Mamlouk, 1999)

Without preventative maintenance, safety hazards may appear at shorter intervals, leading to more third-party claims than would be the case had preventative maintenance been used. Consequently, if preventative maintenance is used, it may be possible to make cost savings by reducing safety inspection frequencies.

It may also be the case that the overall footway life following the sequence: new construction – preventative maintenance – corrective maintenance, will be longer than the sequence new – reactive maintenance – corrective maintenance.

On the other hand, recently constructed modern footways utilising new materials and techniques may not need preventative maintenance and very little reactive maintenance to achieve a long life before corrective maintenance is needed, unless the integrity of the pavement structure is weakened by excavation and poor reinstatement.

Further work is needed to investigate fully the economies and risks involved in the alternative approaches to the provision of maintenance.

Typical current arrangements for maintenance are summarised in Figure 4 and Appendix A. The proposed footway maintenance arrangements are shown in Figure 5.

3.2 Inspections

Currently, inspections may be initiated for various reasons:

- Programmed safety inspections to identify individual dangerous defects in need of urgent or immediate attention.
- Reactive safety inspection following a report from the public. Reports from the public, including complaints, indicate areas that might be considered for maintenance.
- Detailed inspections to identify non-urgent defects which can be included in a programme of planned maintenance.
- Inspection of the footway during the Detailed Visual Inspection (DVI) on the adjacent carriageway,
- Annual Coarse Visual Inspection (CVI) in support of an annual condition indicator.
- Follow up of previous surveys.

No changes to the system of safety inspections and emergency response are suggested, but proposals are shown in Section 6 of this report relating to inspection frequency, investigatory level and response time. As well as forming records for the purposes of defence against claims, the results of inspections and action taken contributes to the database and local knowledge necessary to identify possible maintenance schemes.

With funds for maintenance severely limited, many Highway Authorities are not able to carry out detailed inspections (for maintenance) of the whole network on a systematic basis. They identify possible schemes on the basis of CVI, formal and informal reports and records. The selection systems used in Belfast and Edinburgh are shown in table A17 and Table A18 in Appendix A.

Inspections are a significant expense, for example in Northern Ireland inspections necessary to detect hazardous defects amount to about 15% of the expenditure on maintenance (Northern Ireland Audit Office, 2000). Also since surveys are carried out for BVPI and other reasons (a DVI survey of the whole footway network on a four year cycle is currently being proposed), it is suggested that detailed inspections of the whole network are unnecessary. In order to make the best use of all types of inspections and other sources of information, a staged process of prioritisation is proposed, further described in Sections 3.4 to 3.7 of this report.

The Footway Focus Groups agreed that, although some inspections were made from a slow-moving vehicle, all footway safety inspections should be carried out on foot because many defects are missed behind parked cars and are more appropriately identified during walking. However the use of vehicle inspections may exceptionally be considered on very lightly trafficked rural roads to identify very dangerous defects (Category 1, as defined in Section 6 of this report). Some Highway Authorities use a driver only whilst others included a second person in the vehicle during inspections. Where only one person was used, the driver normally stopped to look more closely at isolated defects where warranted. Whichever method is used, operator and public safety during inspections must be of primary concern.

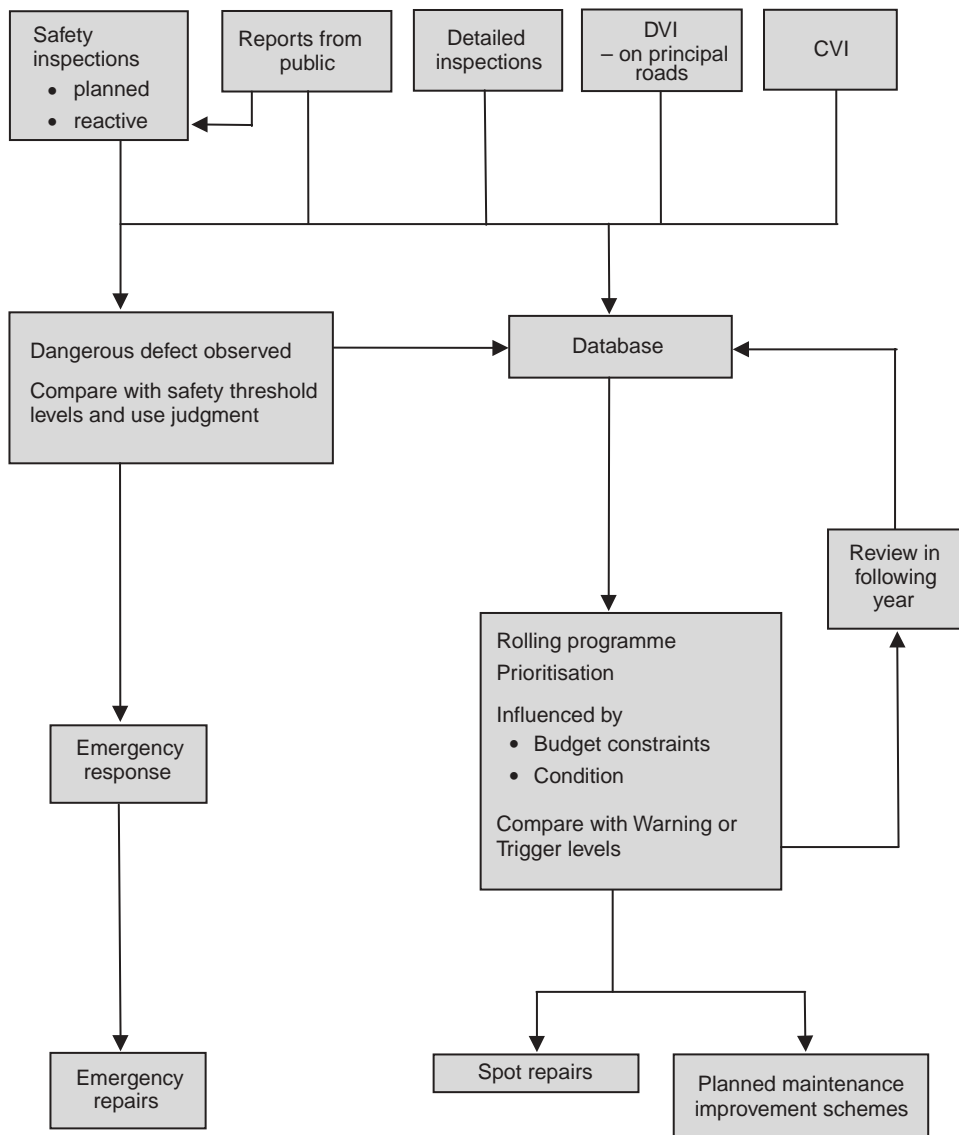


Figure 4 Typical current maintenance system

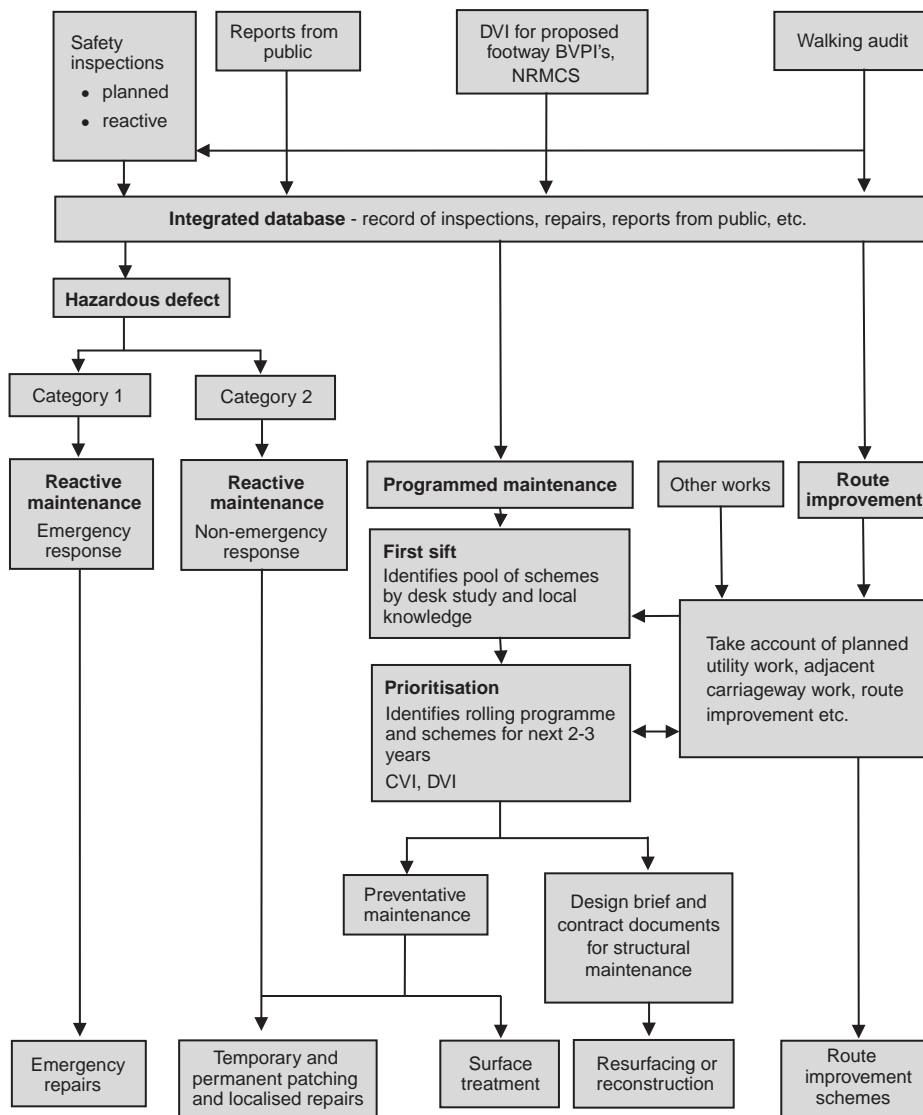


Figure 5 Proposed integrated footway management process

There may be value in combining safety with other forms of inspections. However the workload, capability and training of inspectors must be considered. It is suggested that the inspections for the first sift investigatory levels described below can be combined with safety inspections. This does not add greatly to the task of safety inspectors, who should in any case have acquired knowledge of their parts of the network that need maintenance work. It is noted that some Highway Authorities even include some elements of detailed inspections with safety inspections, but this does increase the inspectors' task considerably.

It is suggested that Highway Authorities should rapidly initiate an inspection, for example within 24 hours, to a report indicating a dangerous defect. A means of weighing reports from the public will be required to avoid reacting to exaggerated descriptions. The response following this reactive inspection, and an observation of a dangerous defect during any other type of inspection, should be the same as that following a planned safety inspection.

3.3 Walking audit and route improvement

Walking audits and route improvements were proposed in an earlier report by Zohrabi *et al.* (2002). The results of these audits also contribute to the database and local knowledge necessary to identify possible maintenance schemes.

3.4 Asset maintenance

In current practice repairs are determined by the availability of funding rather than a defined level of deterioration. This means that, in some cases, only patching repairs, or reactive repairs to maintain safety are carried out. The consequence, however, is of a deteriorating underlying condition with increased overall cost of maintenance in the long-term if overall standards are to be improved.

Currently not all footway maintenance schemes are initiated for reasons of preventative maintenance. For example utility work, adjacent carriageway work, or street light improvements disrupt the footway such that reconstruction will inevitably be necessary. However, given the increased funding necessary to arrest footway deterioration, Highway Authorities must plan and prioritise footway maintenance schemes.

To make the best use of all types of inspections and other sources of information, a staged process is proposed, to filter, identify and prioritise schemes in a rolling programme two to three years ahead. This is intended to optimise resources available for inspection and planning on those schemes most likely to be selected for maintenance work.

Where funds are limited a simpler prioritisation process is appropriate, consisting of planning schemes for only 1½ years ahead. This is because it is normally easy to identify the worst schemes when these are few in number. Also, over a longer period, utility work cannot be predicted and there are doubts about the predictability of deterioration.

However, it is considered necessary to plan schemes for a minimum of 1½ years ahead. This provides a 'reserve' of

schemes should additional funding become available or cancellations are necessary. It also allows time for consultation with utilities.

3.5 Database and records

The database will contain valuable information from a variety of sources, including:

- Safety inspections.
- Previous surveys, maintenance inspections and walking audits.
- Reports from the public, including complaints, indicate areas that might be considered for maintenance.
- Records of emergency, 'patching' and temporary repairs.

Valuable information may be gained from records of repairs. For example, a high incidence of repairs (clusters) at a location can highlight the need to consider widespread treatment. The recording of patches and temporary repairs is important for this reason. Also, the footway construction thickness observed during repair work is useful in predicting the mode of deterioration and remaining footway life.

A database enables trends to be examined that may indicate the need for increased maintenance funding. These include, for example, levels of valid claims or the proportion of the budget spent on reactive maintenance compared with planned maintenance.

In all cases, records of inspections, defects and intended repairs, including nil returns, are essential. They are necessary to demonstrate that the Highway Authority has taken reasonable measures in maintaining the footway, in defence against any claim. Records should be retained for at least 6 years.

3.6 First sift

The first stage of annual prioritisation provides a list of possible maintenance schemes and is based on local knowledge and a review of information held in the database. It is suggested that footways in the network be considered in viable units for maintenance, for example individual streets or in units no smaller than 100m length for longer footways, and pedestrian zones in convenient units, but no less than 250m².

To supplement or confirm information from the database where necessary, Detailed Visual Inspection (DVI) type footway surveys can be carried out at selected locations.

3.7 Prioritisation

The prioritisation will formalise a rolling programme, with a pool of schemes for the next two to three years and likely schemes for the next 1½ years identified. At this stage the basis for prioritisation will be footway condition assessed by a coarse survey compared with the maintenance investigatory level. This is a relatively imprecise criterion expressed as defective area, and is intended to reflect both deterioration of the asset and reduced serviceability. It is defined in Section 4 of the report and proposed levels are set out in Section 7 (Table 7).

Further prioritisation will identify the current year's schemes. It will be carried out by a full investigation of likely schemes for the next 1½ years. The basis for prioritisation will be footway condition assessed by a detailed survey compared with the maintenance treatment levels and serviceability investigatory levels. These are defined in Section 4, and proposed levels are set out in Section 7 of the report (Table 8) and Section 8 (Table 9) respectively. At this stage an assessment will be made of whether the current budget is satisfactory and whether the number of schemes requiring urgent work can be carried out. Current pavement management systems, such as the United Kingdom Pavement Management System (UKPMS, 1998/99) assist in selection of treatment and prioritisation. Those locations not selected may be considered in following years, using further records and judgement as to the extent of further deterioration.

Prioritisation will take many factors into account, for example footway deterioration, serviceability, Highway Authority policy, footway category, local knowledge, engineering experience and budgetary constraints. Also it should be based on whole-life cost techniques that consider both the construction and maintenance costs of the footway over the known or assumed life.

3.8 Other factors influencing programmed work

It will be necessary to take account of other planned work, either to postpone or bring forward footway maintenance schemes. Major utility work may trigger re-construction of footways, with opportunities for cost sharing. Also hybrid schemes may be formed with any other schemes identified for route upgrade as appropriate.

Trees, although encouraged in urban areas, can cause damage to footways through root action. Options which require expenditure are either to prune or crown trees, apply thicker construction over the root area, or make provision in maintenance planning for resurfacing at tree locations, which would be required approximately every six years. However some Highway Authorities have found that the public will accept larger defects around trees in residential areas because of their desire to retain trees and the visual clues to the possible presence of defects provided by the trees themselves.

3.9 Maintenance schemes

Maintenance schemes will be designed on the basis of a DVI-type inspection. Where only short term or preventative maintenance is carried out, the scheme should be reconsidered for further work in the following years.

3.10 Footway categories

Highway Authorities categorise their footways for the following reasons:

- 1 To effectively comply with the requirements of the Highways Act 1980, where footways should be categorised in terms of location and usage, linking those categories to standards of inspection and maintenance,
- 2 To provide a systematic approach to maintenance, which will be based on a categorised and comprehensive inventory.

The Footway Focus Groups agreed that footways should be categorised by usage and the risk of accidents, but flexibility is important to account for different types of Authority. North Yorkshire, for instance, has a large tourist population resulting in wide seasonal variations in pedestrian flows.

Application of the old LAA Code footway categories in practice has shown that the categorisation cannot be based on absolute pedestrian volume alone. A properly identified main shopping area in a market town may be significantly less busy in volume terms than a busy urban area in a major city. Hence, the categories are more sound if primarily based on a commonly and locally accepted perception of the environment of which the footway forms a significant part.

With the objective of making footways more attractive and improving serviceability it will be necessary to prioritise resources. Earlier TRL research identified the scope for adopting key pedestrian routes connecting important journey origins and destinations, such as shopping areas, bus stops, schools, hospitals, and places of potential demand. These key pedestrian routes form a basis for prioritising resources to maximum benefit. The proposed footway categories are shown in Table 3, and a summary of current categories is shown in Table A2 of Appendix A. Four categories are proposed which roughly correspond to those in the old LAA Code, with a sub-division of Category 1. This provides Highway Authorities

Table 3 Proposed footway categories

<i>Category No.</i>	<i>Category name</i>	<i>Brief description</i>
1a	Prestige walking zones	Prestige areas in towns and cities with exceptionally high usage, such as Princes Street in Edinburgh and Oxford Street in London.
1	Primary walking routes	Busy urban shopping and business areas, and main pedestrian routes linking interchanges between different modes of transport, such as railway and underground stations and bus stops etc.
2	Secondary walking routes	Medium usage routes through local areas feeding into primary routes, local shopping centres, large schools and industrial centres etc.
3	Link footways	Linking local access footways through urban areas and busy rural footways.
4	Local access footways	Footways associated with low usage, including estate roads and culs-de-sac.

with the option of applying higher standards in exceptional circumstances, for example in prestige shopping areas or at popular tourist locations. The distinction between urban and rural may be left to local interpretation, but generally urban corresponds to a conurbation with high volume and rural to villages with low volumes.

Consideration was given to making a separate categorisation on the basis of serviceability (i.e. separate from consideration of safety and maintenance) in order that prioritisation may be effected. Nevertheless, simplicity is considered to be important and key walking routes could be given priority by assigning them to a high category. Therefore, these categories apply to safety, serviceability and asset value considerations.

A Highway Authority should have discretion in placing a footway into any group appropriate to its purpose and usage. Specific guidelines on pedestrian volumes are not currently available. However, the following should be taken into account when assigning footways to categories:

- Pedestrian volume.
- Usage and proposed usage, e.g. busy shopping areas.
- Risk analysis, risk management and level of accidents.
- Age/type of footway, e.g. old flagged footways may require more frequent inspection than newly laid or flexible surfaces, so they could be placed in a higher category.
- Footway alongside busy road.
- Footways subject to overrunning problems or high levels of utility reinstatements.

A typical footway network may include 5-10% in Categories 1 and 2, 15-20% in Category 3 and some 75% in category 4. Footways include remote housing footpaths, but do not include public rights of way footpaths, which are normally unmade.

Footways adjacent to roads should be inspected on the basis of a footway hierarchy, rather than road hierarchy, because footway traffic does not necessarily correspond to road traffic. For example the most heavily trafficked footways are in pedestrianised areas, and key walking routes may be sited to avoid heavily trafficked roads.

Highway Authorities will have to set their individual footways in categories. This should be done with care because, in defence against claims for damages, Authorities are frequently cross-examined about the category set for an individual footway. For example, the Institution of Highways and Transportation (2000) suggests that footway category be periodically reviewed (preferably annually) in the light of changes to land-use and pedestrian flow patterns. Account should also be taken of footway width in setting a category because this will limit pedestrian volume.

3.11 Repairs

3.11.1 General

The treatment option will depend upon the severity and extent of the defect, the consequences of leaving it untreated, the hazard presented and the available budget. To ensure that the maintenance strategy is cost effective consideration should be given to the following:

- Maintenance history of the footway.
- Expected life of the footway.
- Past footway use and anticipated future use.
- Mechanism of deterioration.
- Risk factors such as overrun.
- Likely utility works.
- Range of material options.
- Recycling possibilities.
- 'Do nothing' option.

Timely repair is necessary to achieve long-term value for money. As discussed in Section 2.4 of this report, preventative maintenance techniques, such as slurry sealing, retard deterioration provided it has not reached an advanced state, in which case more expensive reconstruction is required to restore condition. However because of funding constraints, some Highway Authorities are forced to use preventative maintenance techniques as holding repairs. Applied at this stage they are much less effective in preventing deterioration and give poorer value for money than other options. Current repair and treatment options are summarised below in Table 4, and are discussed in detail in the Footways Design and Maintenance Guide Part 2 (TRL, 1997). Whole-life costs will be further considered in later research.

3.11.2 Potholes and patching

Potholes are a serviceability as well as a safety issue and need to be filled to remove the danger to the user and arrest further deterioration. Pothole repair continues to be a maintenance item in the budget of many Highway Authorities, and the appearance of potholes each spring is also a major public relations concern, especially when repairs are short-lived and the same areas are repaired repeatedly. Treatment of potholes therefore should be viewed within the whole strategy of reactive, routine or preventative maintenance. A variety of solutions exist but no one treatment solves all problems forever, at any time of the year. However, there are tried and tested methods and a range of materials, which have proved to be effective.

Guidance on minor maintenance in HD 31/94 (DMRB 7.4.1) includes details on carriageway patching and emphasises the importance of the operation:

- Patching is used to replace defective materials predominantly in the surfacing courses. The intention of patching is to provide a permanent restoration of the pavement. If correctly carried out, deterioration of the surface can be arrested and serviceable life extended. The patching operation is becoming an increasingly vital technique in highways maintenance and it is therefore economically sound to treat patching as an important maintenance operation,
- Patching includes the repair of random areas of defective pavement, but not continuous lengths or whole widths. There are circumstances when an emergency temporary pot hole repair or carriageway patch is required. In these circumstances, the temporary repair shall be replaced with the appropriate material on a planned patching maintenance operation as soon as possible.

Table 4 Treatment options

<i>Repair option</i>	<i>Examples</i>	<i>Reasons for use</i>
Local repairs		
Safety	Temporary ramping of trips; Relay rocking modules or ironwork; Temporary packing of depressions, Cleaning of spillages; Placing of barriers; Temporary patching; Vegetation control (where hazardous).	Response to hazardous defect.
Patching and holding repairs	Surface or overlay patching; Inlaid patching; Slurry surfacing.	Arrest rapid deterioration.
Preventative maintenance		
Bituminous footways	Surface dressing; Slurry sealing; Crack sealing; Microsurfacing.	Arrest fretting, stabilise surface, restore waterproofing. Some techniques: restore skidding resistance.
Vegetation control	Cleaning moss and lichen; Control weeds; Tree management.	Remove or prevent obstruction to footway or drainage, prevent damage to structure.
Surface treatment		
Bituminous footways	Surface or overlay patching, Inlaid patching; Overlay; Crack sealing.	Stabilise surface, restore waterproofing, remove minor irregularities, restore skidding resistance.
Modular footways	Lifting and relaying; Joint repairs; Relaying setts and decorative surfaces; Retexturing; Bituminous overlay.	Remove trips or damaged units, prevent loss of bedding, restore skidding resistance.
Concrete footways	Grinding trip ramp; Scabbling and reinstatement; Joint repair; Retexturing; Bituminous overlay.	Remove trips, restore waterproofing, restore skidding resistance.
Reconstruction		
Bituminous footways	Resurfacing (Consider recycling).	Restore original profile, waterproofing and skidding resistance. Remove oxidised layer.
Modular footways	Lifting and relaying with partial or full replacement or levelling of sub-base.	Restore original profile and skidding resistance (where units replaced).
Concrete footways	Replacement of concrete slabs with partial or full replacement or levelling of sub-base.	Restore original profile, and skidding resistance.
In-situ stabilisation	Cement or lime stabilisation.	
Full reconstruction	Consider recycling.	Normally only required to upgrade capacity to deal with vehicle over-runs.
Kerbs	Replacement.	

Some definitions are:

Pothole: Localised distress in an asphalt-surface resulting from the break-up of the surface and possibly the asphalt base course,

Pothole repair: Temporary or permanent repair of a pothole less than 1.0m at its maximum dimension and of any depth,

Patching: The replacement of defective flexible material, to any depth not less than the wearing course thickness, to effect a temporary repair or permanent restoration.

A 'pie-crust' footway is a thin bituminous surface with an unbound base of crushed stone, gravel, or other unbound material. Potholes are difficult to permanently repair in these footways without substantial work.

Potholes are normally temporarily repaired for safety reasons. They are then permanently patch-repaired, or full-depth repaired, using the appropriate material and method to ensure a long life. The duration of a repair is determined essentially by the extent of preparation possible, i.e. cleaning out of moisture and loose material and priming surfaces. Therefore the temporary and permanent operations may be combined to produce a permanent or semi-permanent repair.

Best practice has to balance the life of different repairs and re-repairs, and efficiency and cost. At the same time, the immediate practical side has to be taken into account with respect to safety for the footway users. It depends on the season, the type of footway and availability of labour, materials or technique (such as spray injection) and any commercial decision to carry out a full permanent repair in one operation or in a follow up visit. At the moment,

Highway Authorities frequently respond to a call out to make holes safe without the additional criteria to make it long-lasting as well.

Records of pothole repairs, easily and cheaply gained, will permit the engineer to identify and confirm instances where more widespread treatment would represent better practice. For example a chain or cluster of continuing pothole repairs in an area indicates a need to plan and carry out structural maintenance by way of inlay, overlay or reconstruction.

4 Footway threshold levels

4.1 Definitions in current practice

It may be helpful to set out the terms used in current practice, which are:

Warning level – represents the point when consideration must be given to some form of maintenance in a future programme, which could be several years away. This state may well be related to the onset of user dissatisfaction (Burtwell Ed, 1995),

Intervention level – represents the point where the level of serviceability becomes unacceptable and remedial works are required. This standard may well be related to the incidence of a predetermined level of personal injury accidents. The choice of maintenance action will depend on the nature of the defects and the cost-effectiveness of the treatment (Burtwell Ed, 1995).

It will be seen that warning level includes concepts contained in both *serviceability investigatory* and *maintenance investigation* levels, as defined below. Similarly, ‘intervention’ level encompasses both *safety investigatory* and *maintenance treatment* levels.

4.2 Proposed safety investigatory level

The *safety investigatory level* is the level at which a defect is reasonably likely to cause danger to users. The interpretation of reasonableness takes into account the character of the footway and likely traffic and is a matter of interpretation for each individual case.

Safety must always be of primary concern and defects affecting safety, requiring a reactive rather than a programmed response, can occur at any time during the life of a footway.

Safety threshold levels will be higher (less onerous) than maintenance investigatory levels for the same footway category, and defects affecting safety are most likely to be of an ‘isolated’ nature rather than general, widespread, deterioration.

4.3 Proposed maintenance investigatory and treatment levels

The *maintenance treatment level* is the optimum point for carrying out remedial works. For example, when prevention of further deterioration becomes more cost effective rather than allowing further deterioration and thus greater reconstruction costs. The timing and exact

nature of the maintenance action will be determined by consideration of the Highway Authority policy, footway category, local judgement, engineering experience, whole-life costs and available resources. *Maintenance treatment levels* will take into account the area of deterioration as well as size of individual defects.

Efficient planning and prioritisation require anticipation of future requirements. The *maintenance investigatory level* is when consideration must be given to some form of maintenance in a future programme, which could be several years away. Ideally, this requires knowledge of the deterioration curves for a range of different types of construction. However, in practice, as footway deterioration curves are not currently available, a decision may be made that the condition is regularly monitored but is ultimately allowed to deteriorate until the *maintenance treatment level* is reached.

‘Intervention’ levels are associated with the Code of Practice Specification for reinstatement of openings in highways (Department of Transport *et al.*, 1992) for monitoring reinstatements and ensuring the activities do not create long-term maintenance problems (Yeomans, 1995). The levels are applicable to newly reinstated footways but are not maintenance ‘intervention’ levels. A summary of these levels is contained in Table A12 of Appendix A. Also for comparison, typical surface tolerances for new construction areas are shown in Table A4 of Appendix A.

Failure is where the footway requires complete reconstruction to restore an acceptable surface standard and residual life.

4.4 Proposed serviceability investigatory level

Where it is required to encourage walking, and funds are available, consideration may be given to improving the footway surface quality at any stage in the life of a footway. *Serviceability investigatory levels* relate to pedestrian comfort and will take into account surface features such as raised edges and undulation, as well as visual appearance. As they are not related to structural condition, they will be lower (more onerous) than *maintenance investigatory levels* for the same footway category, and defects affecting serviceability could be either ‘isolated’ or widespread depending on the prior footway condition.

5 Background to safety threshold levels

The following sections 5.1 and 5.2 are based on a 1999 unpublished discussion document by Burtwell and Luck. The legal background applies to England and Wales, although it is understood that courts in Scotland and Northern Ireland sometimes call on case law of England and Wales.

5.1 Legal background

Prior to the implementation of the Highways (Miscellaneous Provisions) Act 1961, Highway Authorities were only liable for damage or injury resulting from work

which was proved to have been poorly carried out. Since the relevant part of the 1961 Act came into effect, in August 1964, Highway Authorities have had an obligation to maintain public highways to reasonable standards. The current provisions are incorporated in the Highways Act 1980, Section 41 (duty to maintain) and Section 58 (special defence in action for damages for non-repair). In this context footways are part of the highway.

The importance of Section 58 is that it provides the defence 'that the authority had taken such care as in all the circumstances was reasonably required to secure that the part of the highway to which that action related was not dangerous for traffic.' Subsection 2 requires that in judging that defence, 'the court shall in particular have regard to the following matters:

- a the character of the highway and the traffic which was reasonably to be expected to use it;
- b the standard of maintenance appropriate for a highway of that character and used by such traffic;
- c the state of repair in which a reasonable person would have expected to find the highway;
- d whether the Highway Authority knew, or could reasonably have been expected to know, that the condition (of the highway) was likely to cause danger to users of the highway; and
- e where the Highway Authority could not reasonably have been expected to repair that part of the highway before the cause of the action arose, what warning notices of its condition had been displayed'.

Effectively, this legislation requires Highway Authorities to categorise their networks in terms of location and usage, linking those categories to standards of inspection and maintenance.

The interpretation of reasonableness is a matter for each individual case, but it is normal for judgements to take into account precedents from earlier cases. The notable example in footway maintenance is the application of three-quarters of an inch as the maximum safe height of a trip, which is generally regarded as being derived from case law. This has been converted subsequently to a metric value of 20mm and is widely used in deciding whether a particular trip could be regarded as dangerous.

The maximum delay between the identification of a defect at or above the threshold level and the commencement of the appropriate action on site is referred to as the *response time*. The appropriate action within the response time may be a repair of the defect or, exceptionally, may be the making safe of the site, possibly by the provision of semi-permanent warning signs, with a longer period elapsing before repair is practicable. Otherwise, this interpretation is in accordance with the Highways Act 1980 section 58, subsection (2), paragraph (e), quoted above.

5.2 Discussion of the 20mm trip

Reference has been made to the often-quoted derivation from case law of three-quarters of an inch (20mm) as the maximum safe height of a trip.

It seems likely that this value of 20mm or ¾inch derives from the case of *Meggs v. Liverpool Corporation* (1967) (65 L.G.R. 479). The *Encyclopaedia of Highway Law* (1997 rev.) says that this case is about a 'pavement flagstone which had sunk about three-quarters of an inch'. Sauvain (1997) quotes the same case but refers instead to a 'group of uneven flagstones. One of these had a projecting point of a quarter of an inch' (*sic*). As the *Encyclopaedia* is regularly updated, with the quotation in question from the 1997 update, and the value quoted has passed into normal currency, it is reasonable to assume that Sauvain (1997) has misquoted. Both sources agree in all other particulars and that the defect was found to be not dangerous, especially as local people knew of the fault but had not reported it to the Highway Authority. Upholding the decision on appeal, Lord Denning said, 'It seems to me, using ordinary knowledge of pavements, that everyone must take account of the fact that there may be unevenness here and there. There may be a ridge of half an inch (13mm) or three quarters of an inch (20mm) occasionally, but that is not the sort of thing which makes it dangerous or not reasonably safe.' Thus a trip up to and including 20mm in the sort of location in question was not considered dangerous. The judgement does not, of course, say what would have been dangerous.

Other relevant cases quoted by the sources include the following:

13mm would only be dangerous under special circumstances: In 1966 the Court of Appeal expressed reservations about a county court finding that a paving stone with a half inch (13 mm) trip and which rocked constituted a danger. The belief was that 'We are all of us accustomed to walk on uneven and irregular surfaces and we can all of us trip on cobblestones, cat's eyes, studs marking pedestrian crossings, as well as other projections. Such a standard (i.e. 13 mm) should not become a precedent or guide in ordinary circumstances.'

25mm may not be dangerous: In 1968, dealing with a half inch (13 mm) trip, the court said 'The test in relation to a length of pavement [footway] is the reasonable foreseeability of danger. A length of pavement is only dangerous if, in the ordinary course of human affairs, danger may reasonably be anticipated from its continued use by the public who usually pass over it. It is a mistake to isolate and emphasise a particular difference in levels between flagstones unless that difference is such that a reasonable person who noticed and considered it would regard it as presenting a real source of danger. Uneven surfaces and differences in level between flagstones of about an inch (25mm) may cause a pedestrian temporarily off balance to trip and stumble, but such characteristics have to be accepted. A highway is not to be criticised by the standards of a bowling green.'

The *Kindred Associations* (1998) refers to two cases which 'may be regarded as the most up to date and authoritative consideration by the Court ... relating to tripping claims'. A difference of level between 10mm and 12mm was judged not unreasonable. Furthermore, on the

basis of this judgement, it was suggested that an appeal for liability in the other case in respect of a 20mm defect would fail.

Sauvain (1997) points out, '... it has now become common for a difference in the surface of one inch (25mm) to be used as an approximate guide to the point at which the potential liability in a Highway Authority, in tripping cases involving urban pavements, arises'. However, Sauvain then says 'The cases on the extent of the liability of the Highway Authority to maintain road surfaces and footpaths outside of urban areas have been few. Essentially, the test must be what the reasonable user of the highway may legitimately expect of the highway.'

There is a lack of useful case law on non-urban footways, but it thought reasonable to accept that, taking account of the circumstances, trips of greater than 25mm may not necessarily be regarded as dangerous in rural areas. Conversely in shopping areas or near old peoples' homes trips lower than 20mm may be regarded as dangerous. There are informal reports of a court viewing trips of less than 20mm in pedestrianised centres as hazardous. Such claims typically result from insufficient contrasts and delineation between footways and restricted roadways, non-standard kerb heights and drainage channels/systems.

5.3 Highway Authority policies for liability claims

This section summarises policies for liability claims found as part of an unpublished TRL study of road network condition by Jordan and Abell in 1997. The policies concern carriageways, as well as footways. However the 20mm investigatory level is applied in both cases because pedestrians may walk in the carriageway.

A recent unpublished TRL study showed that some Authorities do not define strict inspection periods or investigatory levels. In general, 20mm was cited as the most common 'intervention' level. Some Authorities thought that by publicising details of their inspection regime, liability claims would increase. Some also thought that it would be difficult to defend a court action if specific threshold levels had been broken. However, one Authority viewed the situation in an entirely different light. That Authority had produced a signed Policy Statement, which gave specific details of their inspection strategy, and thought the document had been very useful as defence against legal action.

A wide range of policies is in operation for dealing with liability claims. One Authority had an active (if unwritten) policy of making the claims procedure as difficult as possible. However, as data for the cost of claims for this Authority was not available, it cannot be said whether this policy is effective or not. In contrast, another Authority actively promotes a very simple claims procedure and operates a 24-hour telephone helpline but it also receives one claim for every two kilometres of network each year.

Generally, the Authorities had little contact with claimants (after an initial site visit) as legal departments or insurance companies dealt with claims. This was not the case in Northern Ireland where the Authority deals directly

with all claims and claimants itself. Funds for paying out against liability claims were also normally held elsewhere. However, there were exceptions, and one Authority's insurance company had a policy to settle all claims on receipt of a court order. As the Authority was liable for £2500 excess on its insurance policy, the insurance company could offer settlements up to this limit without necessarily losing money.

Where insurance companies are concerned, it appears that 'out-of-court' settlements are often favoured. One Authority stated that their insurance company would allow a claim to run almost its full course, before offering an 'eleventh hour' settlement just before going to court. This prevents a precedent being set in a field, which is entirely governed by case law. Anecdotal evidence suggests that this policy is not unique.

6 Safety

6.1 Investigatory levels for reactive maintenance

The consensus of the Footway Focus Groups was that most of the dangerous defects were of a trip nature, such as rocking and cracked slabs, raised ironwork, proud kerbs and edges of potholes, etc.

In considering investigatory levels, the Footway Focus Groups broadly agreed that the prescribed base level of 20mm should not be changed, except that discretion should be used in sensitive areas. Reasons given were that this level was widely recognised, a lowering of the threshold would dramatically increase expenditure on inspection and maintenance, and raising the threshold would increase the number of personal injury claims. The Focus Groups indicated that vertical defects (trips) were those most likely to feature in accidents. However, some Highway Authorities were equally concerned with slippery surfaces, overhanging vegetation, tree roots and faulty kerbs. Almost all recorded defects were on flags, kerbs, kerb gaps, raised ironwork, potholes, and also included wear and tear, and ravelling. Missing ironwork and angular defects on blocks also occurred. Rocking slabs were common defects on wider footways. Deep depressions and potholes were a major problem on bituminous footways in some areas.

With regard to legal precedent of what is considered to be dangerous, the background summarised in Section 5 of this report suggests that courts are prepared to consider cases on their merits. They would not necessarily regard a trip of 20mm or even 25mm as being dangerous in all circumstances, but a difference of 25mm may be used as a guide for the approximate point at which liability arises, in an urban area at least. However in some circumstances a trip of less than 20mm might be regarded as dangerous, for example in a pedestrianised area.

Therefore it is suggested that Highway Authorities, in general, should regard a level difference of 20mm as the point at which a defect requires careful consideration as being dangerous. This provides a margin of safety in comparison with 25mm, which is the approximate point at which liability arises.

Current safety defect definitions are summarised in Table A8 to Table A10 in Appendix A. Guidance on presentation of a Highway Authorities' definitions of damage to be repaired within 24 hours (Kindred Associations, 1998) is shown in Figure 6. It is understood that this is not guidance on the level of defect, rather guidance on presentation of definitions.

In 1999 an unpublished study by Burtwell and Luck reviewed current safety 'intervention' levels. They noted that not all Highway Authorities use the same levels, nor was there any attempt made by any individual Authority to vary the level for any particular defect according to its location, either by footway category or by any other classification. They also suggested that where latitude is given to inspectors in applying standards this might leave them vulnerable during court action. Therefore a flexible approach was proposed. This approach included parameters within which the inspector can apply the necessary flexibility using professional skills and experience, based on:

- Footway category and level of usage.
- Type of defect.
- General condition of footway section.
- Main journey purpose of most pedestrians.
- Age profile of users (e.g. nearby sheltered housing).
- Environmental/aesthetic considerations.

For each category of footway and for each type of defect it was proposed there should be a stated base safety 'intervention' level and a range through which the level may vary. However, some comments received from engineers indicate that any variation of threshold level may be too complicated in practice.

It is noted that Atkinson (1997, and reported by Institution of Highways and Transportation, 2000) proposed an approach where response time to safety defect varied both with different trip height and with footway category. Treatment was also proposed for trips of 13mm, and 6mm in the case of the highest category footway. It is understood these were proposed in order to improve standards generally. In this report trips lower than 20mm are considered as a matter for improvement for reasons of serviceability.

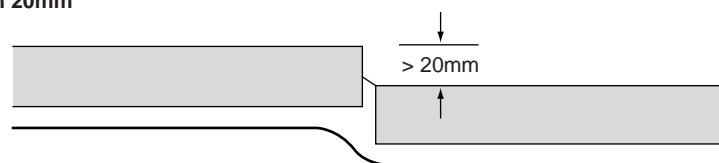
A factor to be taken into account in setting investigatory levels is that during inspection it is not always clear exactly which type of defect is presented. For example, what appears at first to be a large pothole may derive much of its hazardous nature from a sharp edge which forms a trip. It will be an advantage if, as far as it is reasonable, the values of levels for different defects remain common across the range within each footway category.

Proposed safety investigatory levels and response times are shown in Table 5 which have been determined by

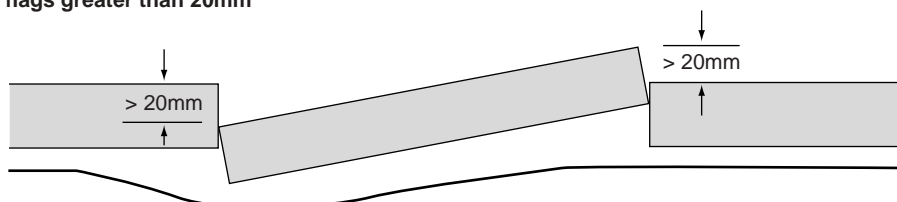
Damage is defined as a defect in the footway which impairs the value or usefulness of the footway and provides a safety hazard for pedestrians, a useful guide is as follows:

- Trips more than 20mm.
- Rocking flags greater than 20mm.
- Rapid change of footway profile greater than 25mm and extending in plan dimension less than 600mm and should be repaired in accordance with individual highway authority response times.

Trips greater than 20mm



Rocking flags greater than 20mm



Rapid changes of footway profile greater than 25mm and extending in a plan direction less than 600mm

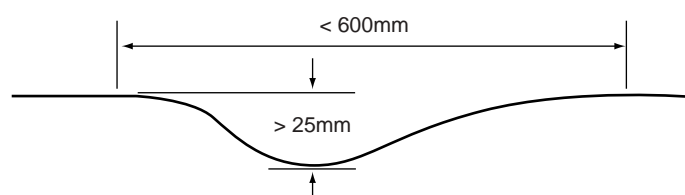


Figure 6 Kindred Associations guidance on definition of damage to be repaired within 24 hours

Table 5 Proposed safety investigatory levels and response times

Defect	Investigatory level mm	Response time code ^a Footway category			
		1 and 1a	2	3	4
Vertical projections (trips), potholes and missing slabs	>20 < 50	H	M	L	L
	>50 < 100	Cat 1	H	M	M
	>100	Cat 1	Cat 1	H	H
Depressions, humps <600mm ^b	>25 < 50	H	M	L	L
	>50 < 100	Cat 1	H	M	M
	>100	Cat 1	Cat 1	H	H
Crack or gap (mm) (>20mm depth)	>25	H	M	L	L
Rocking slabs and ironwork	Deflection – as vertical projections above. However some consider all rocking slabs or ironwork are dangerous.				
Missing kerb	All	H	H	M	L
Loose or damaged kerbs	Projections, deflection, crack or gap as above.				
Low kerbs ^c – height	<75	M	L	L	L
Ironwork	Cracked	H	H	H	M
	Badly damaged	Cat 1	Cat 1	Cat 1	Cat 1
Miscellaneous hazards	Category 1 defects include for example, missing access covers or fallen trees. Category 2 defects include for example, unsafe signing, lighting or guarding of excavations (notify contractor), unsafe steps, slippery surfaces, standing water deflecting pedestrians into carriageway, standing water when freezing is anticipated ^d , persistent snow and ice or leaves on surface and loose surface. Response depends on intensity of use and degree of danger.				

a Response codes *Cat 1* *Make safe or repair within 24 hrs*
H (Cat 2) *Make safe or repair within 5 working days*
M (Cat 2) *Repair within 4 weeks*
L (Cat 2) *Repair during next available programme, schedule more detailed inspection, or review condition at next inspection.*
Target: repair within six months

b Measured from 600mm straight edge.

c Except protected kerbs, or where low kerbs provided by policy.

d Safety threshold levels for footways should also apply on pedestrian crossings and shared traffic/pedestrian areas.

e The response time should always be reduced in the case of a very dangerous defect, for example, even on lightly trafficked footways when the next pedestrian passing is likely to have a severe accident.

f Some Highway Authorities may not wish to include seasonal hazards, but defects that may result in the occurrence of a seasonal hazard should be included.

Some Authorities may consider the above response times too onerous. Those proposed in Table 5 represent an ideal situation. It could only be achieved with adequate funds and resources, but it should generally be regarded by Authorities as a state that should be aspired to. A set of blank proformas are included in Appendix B of the report so that Authorities may set their own levels and response times.

study of current standards, other available literature and guidance from the Focus Groups and the Footway Maintenance Working Group. Response times are discussed in Section 6.3 of this report.

These proposals set out what might be regarded as current general best practice and provide a target for Highway Authorities to aspire to, say, in five years time. Therefore, they also represent what a reasonable user of the footway should generally expect. However, Highway Authorities may adapt these tables to suit their own particular situation.

Consideration may be given to relaxing safety threshold levels in parts of footways less likely to be trodden, e.g. within 200mm to 300mm of a wall or fence, or where degradation can be reasonably expected, e.g. within 200mm of the margin and around trees.

6.2 Safety inspection intervals

Safety inspection frequency is important because, whilst a higher frequency gives greater security that hazards are being recorded and repaired and should lead to fewer accidents and compensation payments, it represents a demand on staff resources. The setting of inspection frequency cannot be considered in isolation from defect thresholds, response times, and the Highway Authority's resources since these determine the length of time defects of particular size remain un-repaired. It is necessary to optimise whole life cost in relation to risk.

The Footway Focus Groups agreed that the footway categories with highest usage or highest accident risk should be inspected more frequently. Thus, old, cracked flagstones should be inspected more often than a new surface. The most frequent safety inspection should

normally be monthly, but could be daily in the busiest locations. The Focus Groups agreed that detailed maintenance inspections should be at yearly intervals. However, in Section 3.2 of this report it is suggested that systematic detailed inspections of the whole network are not necessary.

Proposed safety inspection intervals are shown in Table 6, which have been determined by study of current standards and other available literature and guidance from the Focus Groups and Footway Maintenance Working Group. These proposals set out what might be regarded as current best practice and a target for Highway Authorities to achieve say, in five years time. It is necessary to keep inspection intervals under review. If the number of defects at a location increases, or there is some change in circumstances, then the frequency of inspection should be increased accordingly. Current safety inspection intervals are shown in Table A13, of Appendix A

Table 6 Proposed planned safety inspection intervals

<i>Category No.</i>	<i>Category name</i>	<i>Safety inspection intervals</i>
1a	Prestige walking zones	1 month
1	Primary walking routes	1 month
2	Secondary walking routes	3 months
3	Link footways	6 months
4	Local access footways	6 months

Sauvain (1997) deals with matters of liability relating to regularity of inspection. On the one hand, an Authority was able to demonstrate reasonable care by showing evidence that it had categorised its roads according to degree of usage; that the footway in question was inspected according to that system, and it had adopted that inspection interval after careful consideration and checking of its complaints book. Nevertheless, in other cases, Authorities were held liable in situations where, despite regular inspections, circumstances showed more frequent inspections were necessary. This suggests the necessity of monitoring results of inspections and increasing their frequency in response to the speed of hazards developing.

The Kindred Associations (1998) report one case where the courts accepted that the inspection system of one month was reasonable. However, it should be noted that the footway category was not stated. The FMWG regarded one month as the shortest inspection interval normally necessary, but considered there might be special circumstances where more frequent inspections might be necessary; for example in prestige shopping areas. An interval of one year was regarded as too long even for the lowest category footway; twice-yearly inspection has the advantage of being linked with seasonal effects. In any case there are merits in carrying out an inspection in early spring, because this is when most defects become apparent; repairs can then be planned at the start of the new financial year and be undertaken in the summer. Special local factors may influence inspection frequency, for example, taking account of wear and tear caused by buses with access to pedestrian areas.

It is thought that best value is represented by increased frequencies of safety inspection as this could result in positive cost benefits by reducing claims and overall maintenance expenditure. A preliminary analysis of information on claims and inspection frequency confirms a trend of reduced number of claims with increasing inspection frequency, but attempts to relate cost of claims to inspection frequency proved inconclusive. Further research is required to clarify the position. There have been reports that footway claims amounted to 80% of some Highway Authority's total expenditure on claims; therefore, there are merits in targeted inspection of footways. It is claimed that one Highway Authority paid only £69 in claims in the current year as a result having introduced an 'aggressive' safety inspection and repair regime.

Reducing the inspection interval justifies extending the response times. The suggested inspection intervals and response times exclude experience of the approach used in Northern Ireland, where the liability and legislative background may be different from the rest of the UK, but suggests that an alternative approach to inspection frequency and response times may be possible. The Province has a generally higher frequency of inspection but longer than usual response time for smaller safety defects. Therefore, overall a dangerous defect is likely to remain un-repaired for less time. Courts are prepared to accept that the 20mm defect requires a less rapid response than a 50mm or 100mm defect. However, levels of claims have reduced which may be explained by the formation of a dedicated claims-handling unit, but also implies that the courts accept a clearly defined system even if safety levels and response times are longer than standards quoted elsewhere.

6.3 Response time

The Footway Focus Groups agreed that response times of defect treatment and emergency work must be realistic and be related to the severity of the defect, pedestrian usage and consequent accident risk; the class of footway also affects response time. A well-defined matrix of footway category, defect and response time makes the successful defence against personal injury claims more likely. However, the application of this matrix does not necessarily result in footways providing an acceptable level of service for the pedestrian.

Current response times are summarised in Table A14 of Appendix A. The range of current practice is illustrated by two examples:

- 1 The Kindred Associations (1998) reported on the issues surrounding highways liability claims. Examples of definitions of defects warranting a 24-hour response are given in Figure 6 in Section 6.1,
- 2 The TRMM (Highways Agency, 1996) lists certain defects to be noted and ultimately corrected following detailed inspections which includes projections greater than 20mm. Category 1 defects, that require an urgent response within 24 hours, are not specifically defined.

The rapid response within 24 hours can be much more costly than a routine response after a few days. Also, in many cases it appears unreasonable to repair a defect

within 24 hours after an inspection interval of several months. Therefore, based on consultation with the Footway Maintenance Working Group, it was considered that only very dangerous defects should be classified as Category 1, requiring to be made safe or repaired within 24 hours in accordance with the new code of practice (IHT, 2001).

Proposed response times are shown in Table 5, which have been determined largely by study of current standards and other available literature. Guidance from the Focus Groups and Footway Maintenance Working Group has also been taken into account. Response time should be defined from the time of observation in the safety inspection.

These proposals set out what might be regarded as current best practice and provide a target for Highway Authorities to achieve, say, in five years time. It is not suggested that Highway Authorities adopt these tables and categories rigidly, but they should adapt the relationships between defect and response time to suit their own particular situation.

Highway Authorities should set targets that are achievable in practice. In their earlier work Burtwell and Luck (1999) listed the following factors to be taken into account when setting response time:

- Footway category and level of usage.
- Type and severity of defect.
- General condition of footway section.
- Main journey purpose of most pedestrians.
- Age profile of users (e.g. nearby sheltered housing).
- Environmental/aesthetic considerations.
- Availability of repair materials and travelling time of repair gang.
- System which allows repair gang to be available when needed.

It is important to ensure that any hazardous defects do not deteriorate to a dangerous condition before the next inspection.

A possible approach for developing a rational basis for determining safety threshold levels, inspection frequencies and response times is by risk analysis (see also Yeomans, 1995). For example, it might be possible to determine the defect threshold such that there is a probability of 1 in 500 that a pedestrian passing will be injured. The response times could be set to match the interval in which, say, 100 pedestrians will pass. This illustrates how the response time must be related to the footway usage and character. It is for this reason that an inspector should have freedom to shorten response times. For example, when finding a defect of such danger that the next person passing is likely to be injured, then a very short response time is necessary. The inspection interval could be related to both footway usage and likely time of development of defects. This approach is not considered further in this report, but may be considered in future work after further consultation.

The Footway Focus Groups identified a larger number of defects exceeding the 20mm threshold level in Northern Ireland and northern England than in southern England. It would be reasonable to treat such defects very seriously if

only one or two were found each day. However, it was suggested that the numbers found in Northern Ireland could be as many as 200 per day and therefore it would not be reasonable to expect immediate repairs on a footway inspected only once per year. It is planned to investigate the level and frequency of defects in other areas in future work.

7 Investigatory levels for planned maintenance

As previously discussed in Section 4 of this report, the *maintenance treatment level* is the optimum point for carrying out remedial works, and the *maintenance investigatory level* is when consideration must be given to some form of maintenance in a future programme which could be several years away. The timing and exact nature of the maintenance action will be determined by consideration of the Highway Authority policy, footway category, local judgement, engineering experience, whole-life costs and available resources. Maintenance treatment levels will take account of areas of deterioration as well as individual defects. Current standards are summarised in Table A5, Table A6 and Table A7 in Appendix A, where it is observed that they consist of three parts:

- 1 A qualitative description of defective conditions, such as cracking.
- 2 A threshold of defective conditions, e.g. greater than 20mm wide, defining the term cracking above. In some cases a threshold is not defined.
- 3 'Intervention' levels for different categories and treatments are normally expressed as area, for example, 20% for Category I in the old LAA Code. Treatment is indicated when one type, or an accumulation of different types, of defect exceed the treatment level. This represents the reality where a footway might be subject to a variety of defects, which together reduce the condition of the footway. In computerised pavement management systems the threshold levels for treatments are more complex, but essentially the algorithms include a weighted accumulation of the areas of defects.

The UKPMS includes a staged assessment of condition using the Coarse Visual Inspection (CVI) and Detailed Visual Inspection (DVI). It is noted that definitions of defects for use with both the CVI and DVI are identical, except that CVI defects are an accumulation of the DVI defects. For example the CVI defect Minor Bituminous Deterioration includes both Minor Cracking and Minor Fretting which would be distinguished in a DVI.

A *maintenance investigatory level* is proposed for use with the prioritisation process described in Section 3.7 of this report, expressed as area of deterioration or discomfort to walking, as shown in Table 7. It will be noted that this approach is very similar to that used in the old LAA Code; however, levels have been reduced to reflect a desire to improve standards. The levels reflect both serviceability and asset value considerations and are the sum of defective areas, either of a single type, or a combination of different types.

Table 7 Proposed maintenance investigation levels

<i>Proposed footway category</i>	<i>Threshold of defective area</i>	<i>Guideline for defective area</i>
1 and 1a 2	Local deterioration or discomfort to walking, and areas of temporary repairs	5 – 15%
3 4	Some deterioration or discomfort to walking, and areas of temporary repairs	15 – 30%

For the further prioritisation described in Section 3.7, *maintenance treatment levels* are proposed as shown in Table 8. These are expressed as a description of defect and threshold of defective conditions.

Table 8 Proposed maintenance treatment levels

<i>Defect description</i>	<i>Threshold guideline</i>
Bituminous	
Coarse cracking	>2mm wide
Coarse crazing	>2mm wide
Loss of material, scabbing or fretting of stone from surface	
Areas of undulation, depressions or bumps ¹	>25mm in 500mm
Vertical projections (trips)	>10mm
Areas of temporary repairs, reports of hazards, history of defects	From records
Slippery surface ²	
Flags or blocks	
Vertical projections (trips)	>10mm
Missing flags or blocks	
Rocking flags	
Areas of undulation, depressions or bumps ¹	>25mm in 500mm
Cracks or gaps	>20mm wide
Areas of temporary repairs, reports of hazards, history of defects	From records
Slippery surface ²	

¹ *Might cause stumbles and trips, uncomfortable for walking, or contain standing water.*

² *It is considered that slipperiness be defined by inspectors, as it is thought impractical to use measuring devices on a routine basis at present.*

For estimating purposes, the area of deterioration due to a spot defect such as a ‘trip’ is the length or area that needs to be repaired to rectify the defect.

Patching and temporary repairs are listed as defects for inclusion in the prioritisation process. This is to avoid any reluctance on the part of Highway Authorities to carry out temporary repairs on the grounds that an improvement in any Condition Indicator may result in a section of footway becoming less eligible for improvement.

8 Serviceability levels and user satisfaction issues

User satisfaction levels were investigated by Leake *et al.* (1991). They attempted to define these requirements which

were expressed as the level where pedestrians express neither satisfaction nor dissatisfaction with footway surface characteristics. Also a ten year improvement in maintenance standards for the reason of user satisfaction is proposed (Atkinson, 1997). These proposed thresholds are summarised in Table A15 of Appendix A.

A TRL study in 1998, involving 24 different sites in Reading and Leeds, included interviews with over 2000 footway users who were asked to rate the condition of the particular site. The surface profile was measured at each site by the prototype WDM Footpath Profiler and a number of parameters were derived to summarise the site condition. These parameters were used to investigate the correlation with users’ ratings. A better correlation was found between the ratings predicted by the measured condition parameter models and the mean user rating for each site than between the ratings predicated by the inspectors’ assessments and the mean user ratings for each site. It was found that pedestrians were more sensitive to indicators of transverse unevenness than longitudinal unevenness, and it was suggested that these could form the basis for a Condition Indicator.

The Footway Focus Groups indicated that there could be a possible role for a simple profile measuring device if its measurements correlated well with user response. It could be used to provide an objective measure of serviceability closely related to a user satisfaction index from a representative sample of the footway network

User satisfaction surveys of a more general nature are already carried out on the Highways Agency trunk road network. The major drawback with such satisfaction surveys is that their conclusions are inevitably subjective. User expectations are often based upon perceived standards of achievement and, as with any aspect of public opinion, expectations change over time. It is also impossible to collect satisfaction data from all network users, which therefore necessitates the development of a sampling technique. Conclusions drawn from sampled data must be treated with a degree of caution, particularly if there is reason to be concerned that the sample may not be truly representative of the whole population. This could well be the case with user satisfaction questionnaires, which may attract a higher level of response from dissatisfied users, biasing the sample to systematically underestimate user satisfaction. Also, users are frequently unable to make an assessment of the important aspects of serviceability, such as skidding resistance, and these are not included in the users’ own level of satisfaction, although potential skidding risk features highly amongst users’ concerns.

Consequently, whilst information on user satisfaction is important, as it provides an opportunity for users to voice their concerns, it should not be regarded as the only source of information used to measure achievements on the network. The lack of objectivity inherent in user satisfaction levels is an important constraint on their usefulness.

User comfort is defined, in its widest sense, as an objective measure of the quality of service provided by the Highways Agency all-purpose trunk road network. It must therefore include such diverse aspects as ride quality,

amenities on the network (e.g. street lighting, emergency telephones) and amenities provided to support the network (e.g. the frequency of service facilities). The major problem is whether to develop a method that combines these diverse data or to report them separately in a concise fashion. The data themselves are largely available or could be readily collected.

Proposed serviceability investigatory levels are shown in Table 9.

The proposed thresholds have been determined largely by a study of current standards and available literature, which are summarised in Appendix A.

In the future, with increased and sustained maintenance expenditure, higher standards could progressively be applied. Indeed as mentioned above, a ten-year improvement in maintenance standards is proposed as an objective (Atkinson, 1997). Individual Highway Authorities must set their own standards and therefore they will have the option to adapt these standards depending on their local circumstances.

9 Other issues

9.1 Automatic recording of defects

Research reported by Spong and Cooper (1994) made use of two different types of footway profilometer to automatically record and analyse footway surface irregularity. The results indicated that an objective measure of footway surface profile may be related to subjective impressions of serviceability. However, the two profilometers used in the experimental work were quite large and rather cumbersome and were not entirely suited to large-scale monitoring of footway networks. It may be possible to produce a simpler, more manoeuvrable, version of a profile-measuring device that could be used selectively on a sample of the network to provide an objective assessment of serviceability. Such a device could also be used as a 'standard' to check the repeatability and reproducibility of visual inspections and inspector performance.

Hand-held data-capture devices are widely used in visual inspections to record footway condition. The recorded data is downloaded into a computer system for analysis and storage in a database.

Table 9 Proposed serviceability investigatory levels (These levels are purely provisional and are subject to revision following consultation)

<i>Defect description</i>		<i>Threshold level</i>			
		<i>Proposed footway category</i>			
		<i>1 and 1a</i>	<i>2</i>	<i>3</i>	<i>4</i>
Uneven surfaces	Depth/height (mm)	>10	>10	>15	>20
	Dimension (m)	1.0	0.6	0.6	0.6
	No. per 100m	5	5	10	20
Potholes	Depth (mm)	>10	>10	>15	>25
	Width (m)	<0.6	<0.6	<0.6	<0.6
	No. per 100m	1	2	3	5
Projections (trips)	Height (mm)	>10	>10	>15	>20
	No. per 100m	5	5	10	20
Areas of cracking, crazing and patching	Crack width (mm)	>10	>10	>10	>10
	Percentage area affected per 100m	10%	15%	20%	30%
Rocking slabs and ironwork- deflection	Height (mm)	>10	>10	>15	>20
	No. per 100m	5	5	10	20
Standing water	Area (m ²)	>0.25	>0.5	>0.5	>1
	Usable footway width (m)	<2	<2	<1.5	<1
	No. per 100m	1	2	3	5
	Reduced capacity		Deflects pedestrians into carriageway		
Standing water in carriageway	No. per 100m	1	2	3	5
		Splashes onto footway and pedestrians			
Damaged kerbs	% of length per 100m	5%	5%	10%	20%
Inadequate kerb upstand	% length per 100m	5%	10%	10%	20%
	Height ^a (mm)	<75	<75	<75	<75
Slippery surfaces ^b					
Loose stones	Extent of damage % of surface	5%	5%	10%	20%

a Except protected kerbs, or where low kerbs are provided by policy

b It is considered that slipperiness be defined by inspectors, as it is thought impractical to use measuring devices on a routine basis at present.

Locational referencing can now be effectively carried out on rural networks using GPS, but there are difficulties in urban areas where the satellite signal reception is impaired by high buildings.

9.2 Inspection methods

The inspection method will depend on the level of detail required. In the case of safety inspections there are difficulties in accurately assessing many footway defects from a slow moving vehicle, e.g. rocking slabs, and there are legal grounds for recommending that inspections be done on foot. It is often argued that 'footways are made for walking so condition inspections should also be made by walking'.

UKPMS (1998/99) notes the difficulties of viewing defects from a moving vehicle. Detailed inspections should normally be carried out on foot, whereas it might be possible to conduct coarse inspections of footways close to the carriageway, in rural areas where there are no parked cars, from a moving vehicle.

An earlier TRL Report (Zohrabi *et al.*, 2002) on the use of Condition Indicators recommended provision inspections to monitor improvements in serviceability, and to record defects not necessarily related to the footway surface, e.g. security and amenity.

There is, at present, no standard method for measurement of slip resistance on footways, although a pendulum test method has been used on a number of occasions.

9.3 Conservation areas

Traditional forms of paving, e.g. stone setts, may have surface irregularities which exceed current and proposed thresholds, but are often tolerated for aesthetic reasons. This shows that members of the public can cope with poor surface condition where this is not unexpected and is in keeping with the surroundings.

10 Conclusions

This report reviews and investigates current threshold levels with the aim of establishing realistic values for maintenance treatment. These cannot be viewed in isolation from other aspects of the maintenance system that each Highway Authority will have in place. Therefore the report also examines the overall maintenance system and the necessary procedures for inspection, assessment, prioritisation and selection of treatment. The following conclusions are drawn:

- The benefits of timely highway maintenance are normally illustrated with the aid of idealised deterioration curves. However, unlike carriageways, which are significantly affected by vehicle wheel loading, footway deterioration is mainly due to ageing except where it is due to vehicle overrun, utility works and reinstatements. Consequently, deterioration curves are not appropriate for footways.
- Systematic detailed inspections of the whole network are not considered necessary, rather a staged process of inspection is proposed which optimises available

resources for inspection and planning, concentrating on schemes which are most likely to be selected for maintenance action.

- The proposed process consists of a first selection of schemes based on information to hand, supplemented by a preliminary coarse type of inspection and followed by a selection based on a detailed inspection and choice of treatment.
- Three different types of threshold level are proposed: Safety, Maintenance and Serviceability,
- Provisional investigatory threshold levels, inspection intervals and response times, based on those in currently used codes are proposed.
- The proposed thresholds and associated aspects of the maintenance system are not obligatory and are presented for guidance, comment and consultation only. They do not represent Highways Agency policy and cannot be used to define liability in any way.

11 Recommendations

It will be necessary to review the proposals contained in this report following the responses from consultation.

In this report threshold levels have been determined on the basis of current practice. Further research may be required into the following:

- 1 The possible use of automatic data-collection devices and their relative merits in defining serviceability.
- 2 The relevance of physiological aspects of walking to safety and serviceability levels, including the physical assessment of potential hazards such as depressions and humps.
- 3 Investigation into the possibility of defining and calibrating deterioration curves of footway condition, which would be of assistance in determining maintenance levels.
- 4 Develop the new coarse and detailed visual inspection surveys specifically for footways.
- 5 Develop a method of measurement of slip resistance of footway surfaces to establish relevant slip coefficients and standards.
- 6 Develop a risk analysis and cost benefit approach based on analysis of information on defects, inspection intervals, response times and claims.
- 7 Investigate regional variation in defect occurrence.
- 8 Assess the effectiveness of methods of prioritisation of footway maintenance schemes, including an evaluation of the usefulness of Whole Life Cost, and other economic considerations.

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Appendix A: System comparison tables

Table A1 Key to systems

<i>System</i>	<i>Reference document</i>
Old LAA Code of Good Practice	Highway Maintenance – A code of Good Practice, Local Authority Associations (1989).
Somerset CC	Highway Inspection Manual. Environment Department Somerset County Council (1996).
SW Counties	South West Counties Category 1 Defects (Yeomans, 1995).
Rhondda	Rhondda Cynon Taff Highway Inspectors Procedure (private communication (2000)).
Kindred Associations	Report on highway liability claims – The Issues 1998, Kindred Associations (1998).
MARCH	MARCH 2 Engineers Manual. The March Group (1983).
CHART	Department of Transport (1986).
TRMM	Highways Agency (1996).
DRD (NI)	Road Maintenance Standards – Roads Service. Department of Environment (Northern Ireland) (2000) (now Department for Regional Development).
UKPMS	UKPMS – Getting Started – A guide for managers and users. United Kingdom Pavement Management System (1999) and UKPMS Rules and Parameters Project, Visual Inspection Defects - Version RP2.0 Updated 8th February 2000.
Highway Maintenance Handbook IHT (2000)	Footways, by Derek Pearson, in Highway Maintenance Handbook, Edited by Atkinson (1997). Guidelines for Providing Journeys on Foot. Institution of Highways and Transportation (2000).

Table A2 Footway categories used

<i>System</i>	<i>Categories</i>
Old LAA Code of Good Practice (1989)	I Main shopping areas. IIa Busy urban/shopping (flexible). IIb Busy urban/shopping (rigid). IIIa Less used urban and busy rural (flexible). IIIb Less used urban and busy rural (rigid). IV Little used rural.
Somerset CC (1996)	1 Associated with class 1 and 2 roads. 2 Other very busy urban footways. 3 Associated with busy urban distributor roads – Class 3. 4 Associated with other class 3 and urban class 4 roads. 5 Associated with rural class 4 roads. 6 Segregated footways.
Rhondda (2000)	Same categories as old LAA Code of Good Practice.
Kindred Associations (1998)	Assumes common standards for all categories and therefore categories are not relevant.
MARCH (1983)	01 Very heavily used footways. Town centres, Major shopping centres, Pedestrian precincts, Footways near schools and large factories etc. 02 Heavily used footways. Small shopping parades, Footways near schools and offices not covered by 01, Near community centres. 03 Frequently used footways. Main footways in residential areas, Village streets 04 Little used footways.
TRMM (1996)	Footways are not categorised as such and are dealt with as extensions to the broad Road Categories A, B & C.
CHART (1986)	a Urban footways – inner. b Urban footways – outer. c Rural footways – busy. d Rural footways - little used.
DRD(NI) (2000)	1 High Traffic– town and city centres. 2 Medium Traffic - busy urban. 3 Low Traffic – housing estates, other urban footways, rural areas. (Estates with high incidence of defects – inspection interval as 2).
UKPMS (2000)	One category of footway. Hierarchy applied at discretion of user.
Highway Maintenance Handbook (1997)	1 Extremely heavily used footways. <ul style="list-style-type: none"> ● City centre shopping streets, ● Main central access ways, ● Pedestrian precincts. 2 Very heavily used footways. <ul style="list-style-type: none"> ● Other local business areas, ● Local shopping areas. 3 Heavily used footways. <ul style="list-style-type: none"> ● Near schools, hospitals, libraries, community centres, shopping locations and those not covered in 2, residential access ways. 4 Frequently used footways. <ul style="list-style-type: none"> ● Footways in the residential streets. 5 Little used footways. <ul style="list-style-type: none"> ● Footways in residential areas, ● Rural areas. 6 Little used industrial or rural footways.
IHT (2000)	Same categories as old LAA Code of Good Practice.

Table A3 Materials

<i>System</i>	<i>Materials</i>		
Old LAA Code of Good Practice (1989)	a Flexible	b Rigid	
Somerset CC (1996)	Flexible Rigid modular Concrete (no separate standards)		
Kindred Associations (1998)	No specific differentiation, but highlights modular-specific, e.g. rocking slabs		
MARCH (1983)	Flexible Rigid		
TRMM (1996)	Rolled Asphalt Surface dressed Bitmac	Concrete flags Concrete Block paving	Other
CHART (1986)	Flexible Rigid – flags		
DRD(NI) (2000)	No specific differentiation		
UKPMS (2000)	Bituminous Block paving Concrete Flags		
IHT (2000)	Same categories as old LAA Code of Good Practice		

Table A4 New construction surface tolerances (Footways Design and Maintenance Guide Part 2 (TRL, 1997))

<i>Parameter</i>	<i>Tolerances</i>
Surface regularity	The maximum deviation of the footway surface under a 1m straight edge shall not exceed 3mm.
Wearing course	The wearing course level shall be within +5mm and –0mm of the adjacent kerb, edging strip or any ironwork.
Joints between flags and pavers	Joints shall not be less than 2 mm and not more than 5mm wide. For pedestrian only footways flags can be laid with wide (6-10mm) joints filled with compacted mortar.
Horizontal alignment accuracy	Horizontal alignments shall be correct to within 25mm, except for kerbs, channels and edges strips which shall be correct to within ± 13 mm.
Kerbs and edging strips	The surface level shall be within ± 6 mm of the design level.

British Standards give different tolerances for different materials. The tolerances given are intended to apply generally and also take into account that a footway is usually laid by hand.

Table A5 Maintenance intervention levels

<i>System</i>	<i>Maintenance intervention levels</i>	<i>Treatment</i>
Old LAA Code of Good Practice (1989)	Cat. I >20% area Cat. II >30% area Cat. III >40% area Cat. IV when potentially dangerous	Restore surface Restore surface Restore surface Patch or restore surface
MARCH ¹ (1983)	Minor flexible >65% area Major flexible >10% area Major rigid >10% area	Surface treatment { Major 10%– 50% Reinstatement { Major 50% – 100% Resurface { Minor >65% + Major >10% Resurface
CHART (1986)	Rating calculated when area affected >10% area (urban) >20% area (rural)	
UKPMS (2000)	CVI defects Local (5% to 20% area or length) Partial (20% to 40% area or length) General (>40% area or length) DVI defects Extent recorded as: Area, length or number in 20m sections	
Highway maintenance Handbook (1989)	Cat 1 >20% area (equivalent major deterioration) Cat 2 >22% area Cat 3 >26% area Cat 4 >30% area Cat 5 >35% area Cat 6 >40% area	
IHT (2000)	Cat. 1 >10% area Cat. 2 >20% area Cat. 3 >30% area Cat. 4 when potentially dangerous	Restore surface Restore surface Restore surface Patch or restore surface

¹ Some levels set by user, this information from Atkinson (1997).

Table A6 Maintenance defect definitions and thresholds

<i>System</i>	<i>Maintenance defects</i>	
Old LAA Code of Practice (1989)	Flexible	Coarse cracking of the surface Coarse crazing
	Rigid	Cracks or gaps >20mm wide and > 6mm deep Rocking slabs which are not dangerous
	All	Depressions >25mm deep Trips >13mm <20mm
Somerset CC (1996)	Pothole Major cracking Minor cracking Fretting Slab profile – uneven/trips/gaps Standing water Overgrown by vegetation, damaging surface Defective trench, (>10mm trip, report to SU)	
MARCH ¹ (1983)	Minor flexible	Fine crazing <2mm Loss of aggregate
	Major flexible	Cracking >2mm Coarse crazing >2mm Fretting/scabbing Depressions > 25mm deep Trips >13mm, <20mm Standing water >6mm deep >1m ² area
	Major rigid	Projections >13mm, <20mm Depressions > 25mm deep Cracks or gaps >20mm wide & >6mm deep Rocking flags Standing water >6mm deep >1m ² area
CHART (1986)	Flexible	Cracking Crazing Fretting Deformation likely to affect users and hold water
	Flagged footways	Steps 13mm - 20mm Depressions 20mm –25mm Appreciable deformation or undulations or unevenness likely to affect users Cracked only flags >50% with single cracks, >40% with multiple cracks
UKPMS (2000)	See following tables	

¹ Some levels set by user, includes information from Atkinson (1997).

Table A7 UKPMS maintenance defect definitions

<i>Surface type</i>		
<i>CVI – defect</i>	<i>DVI - defect</i>	<i>Definition</i>
<i>Bituminous</i>		
Minor bituminous deterioration	Minor cracking	Fine cracking or crazing with little or no visible crack width when viewed from a standing position.
	Minor Fretting	Loss of material other than surface applied chippings from the wearing surface where the original wearing surface remains discernible.
Major bituminous deterioration	Major cracking	Multiple cracking and coarse crazing.
	Major fretting	Loss of material other than surface applied chippings from the wearing surface to the degree that the original wearing surface is no longer discernible. This may be apparent if larger aggregate in the basecourse is exposed.
	Moderate local settlement/subsidence	Moderate local settlement or subsidence producing a difference level from 10mm to 30mm. This will include patches or public utility reinstatements and areas where the footway has heaved, for example due to tree roots.
	Spot defects	Isolated ‘spot’ defects, such as vertical projections (‘trips’) exceeding 13mm, areas of ponding or depressions and pot-holing.
	Severe local settlement or subsidence	Severe local settlement or subsidence producing a difference in level greater than 30mm. This will include patches or public utility reinstatements and areas where the footway has heaved, for example due to tree roots.
	Longitudinal trip	Vertical projections exceeding 13mm which extends continuously in the longitudinal direction, e.g. along the back of a kerb or along the edge of a reinstatement.
<i>Flagged</i>		
Minor flagged deterioration	Cracked but level flags	Flags which are cracked but have no depressions or vertical projections greater than 13mm.
Major flagged deterioration	Cracked and depressed flags	Flags which are cracked and have gradual depressions or vertical projections greater than 13mm associated with the cracking.
	Depressed flags (not cracked)	Flags which are not cracked but have gradual depressions or vertical projections greater than 13mm.
	Longitudinal trip	Vertical projection exceeding 13mm which extends continuously in the longitudinal direction, e.g. along the back of a kerb or along the edge of a reinstatement.
<i>Block paved</i>		
Minor block deterioration	Damaged blocks	Blocks which are cracked, spalled or otherwise damaged but have no depressions or vertical projections greater than 13mm.
Major block deterioration	Cracked and depressed blocks	Blocks which are cracked and have gradual depressions or vertical projections greater than 13mm associated with the cracking.
	Depressed or missing blocks	Missing blocks or uncracked blocks which have depressions or vertical projections greater than 13mm.
	Spot defects	Vertical projections (‘trips’) exceeding 13mm. Small depressions and Areas of ponding. Potholes. Rocking Blocks. Missing Blocks.
	Longitudinal trip	Vertical projection exceeding 13mm which extends continuously in the longitudinal direction, e.g. along the back of a kerb or along the edge of a reinstatement.
Not recorded	Missing filler	Areas where the joint filling medium is not present. (Not rated, recorded for information only).

Continued

Table A7 (Continued) UKPMS maintenance defect definitions

<i>Surface type</i>		
<i>CVI – defect</i>	<i>DVI - defect</i>	<i>Definition</i>
Concrete		
Minor concrete deterioration	Minor cracking	Fine cracking or crazing with little or no visible crack width when viewed from a standing position.
	Minor scaling/ fretting	Loss of material from the matrix causing exposure of the surface of the coarse aggregate
Major concrete deterioration	Major cracking	Wide Single and Multiple Cracks.
	Severe local settlement/subsidence	Severe local settlement or subsidence producing a difference in level greater than 30mm. This will include patches or public utility reinstatements, gradual depressions associated with cracking of slabs, sudden discontinuities at joints or cracks.
	Major scaling/fretting	Loss of material from the surface leaving the coarse aggregate proud of the matrix or causing loss of coarse aggregate.
	Moderate local settlement/subsidence	Moderate local settlement or subsidence producing a difference in level from 13mm to 30mm. This will include patches or public utility reinstatements, gradual depressions associated with cracking of slabs, sudden discontinuities at joints or cracks.
	Spot defects	Vertical projections ('trips') exceeding 13mm. Small depressions and Areas of ponding. Potholes. Rocking Blocks.
	Longitudinal trip	Vertical projection exceeding 13mm which extends continuously in the longitudinal direction, e.g. along the back of a kerb or along the edge of a reinstatement.
	Spot defects	Vertical projections ('trips') exceeding 13mm. Small depressions and Areas of ponding. Potholes. Rocking Flags. Missing Flags. Gaps between Flags.

Table A8 Safety defect definitions and thresholds

<i>System</i>	<i>Safety thresholds</i>
Old LAA Code of Practice (1989)	Projections >20mm (including manhole frames, boxes, etc.) Dangerously rocking slabs. Cracks or gaps between flags. Isolated potholes. Depressions and bumps. Slippery surfaces.
Somerset CC (1986)	Slab rocking >20mm upstand. Slab missing. Overgrown by vegetation: depending on use, or forces pedestrians into c/way. Trip >20mm. Major cracking >15mm gap and depth, or depending on usage. Pothole >25mm deep <600mm in plan. Standing water if ice likely.
SW Counties (1995)	Trips/rocking slabs >20mm. Pothole small area >50mm. Cracks/gaps >15mm wide and 15mm deep. Missing/sunken ironwork >40mm drop.
Rhondda (2000)	Trips & protruding ironwork >20mm (Cat I), >30mm (Cat II), >40mm (Cat III), > 65mm (Cat IV). Subsidence or raised areas >10% (Cat I to III), 15% (Cat IV) Rocking paving slab \pm 20mm.
Kindred Associations (1998)	Depressions & bumps: >25mm deep & <600mm wide. Trips inc. ironwork >20mm Rocking flags >20mm Potholes >40mm deep & >300mm any direction.
MARCH ¹ (1983)	Projections >20mm. Isolated, cracked, sunken or dangerously rocking flags Isolated potholes. Broken manhole or utility covers Dangerous temporary reinstatements.
CHART (1986)	Potholes. Depressions >25mm deep Bumps>25mm high. Loose stones on hard surfaces Loose, upstanding, sunken or damaged stop-cock boxes and manhole covers. Steps >20mm. Rocking flags. Gaps or cracks >20mm.
TRMM (1996)	No specific definition. All defects identified as a result of safety and detailed inspections or safety patrols classified either: Category 1 Those which require prompt attention because they represent an immediate or imminent hazard or because there is a risk of short term structural deterioration. Category 2 All other defects, assigned high, medium or low priority.
DRD(NI) (2000)	Trips, potholes, >100mm, >50mm, >20mm, response time varies with severity of defect and traffic volume, see Table A11 following. Missing, cracked or damaged ironwork. Cracks or gaps between flags >20mm wide and >20mm deep. Gaps or chips in kerbs and steps >50mm wide and >20mm deep.
IHT (2000)	See Table A9 and Table A10 following.

¹ Some levels set by user, includes information from Atkinson (1997).

Table A9 Intervention levels for safety defects (IHT, 2000)

<i>Defect and intervention level</i>	<i>Comment</i>
Dangerously rocking flags.	No precise definition given in LAA (1989). Kindred Associations (1998) suggests 20mm faulting. Leake <i>et al.</i> (1991) indicates that all rocking flags are categorised as dangerous by the user.
Projections greater than 20mm high (including manhole frames and boxes).	The 20mm upstand ('trip') height results from case law. If the upstand is less than 20mm a successful claim is unlikely. Leake <i>et al.</i> (1991) found that users had difficulties when upstands exceeded 10mm.
Cracks and gaps between flags greater than 20mm wide and more than 6mm deep.	Leake <i>et al.</i> (1991) found that users had difficulties when gaps exceeded 10mm wide.
Isolated potholes – none.	Usually occurs in a bituminous surface and is an indicator of the onset of wearing course failure. In a modular or paved surface, this may be a missing element or paving. No precise definition given in LAA (1989). All potholes are unacceptable regardless of depth.
Depressions and bumps more than 25mm deep or high in a length of 500mm.	Leake (1991) suspected that transverse depressions were more difficult to the user than longitudinal ones. This has subsequently been confirmed by further work undertaken by TRL.
Loose surface – none.	No precise definition given in LAA (1989). No loose surface is safe.
Standing water – none.	No precise definition given in LAA (1989). No standing water is acceptable.
Utility reinstatements – a 10mm upstand or depression indicates the reinstatement is unacceptable under the New Roads and Streetworks Act 1991.	The requirements are more discriminating than has normally been applied to a 'safety' upstand on the footway (DOT <i>et al.</i> , 1992).

Table A10 Safety maintenance intervention levels and response times (IHT, 2000)

<i>Defect</i>	<i>Location</i>							
	<i>a</i>		<i>b</i>		<i>c</i>		<i>d</i>	
	<i>IL</i>	<i>RT</i>	<i>IL</i>	<i>RT</i>	<i>IL</i>	<i>RT</i>	<i>IL</i>	<i>RT</i>
Rocking flags	All	1	All	2	All	2	All	3
Upstand (mm)	>20	1	>20	2	>20	2	>20	2
	13-20	2	13-20	3	13-20	3	13-20	3
	6-13	3						
Horizontal gaps (mm)	>20	2	>20	2	>20	3	>20	3
Isolated potholes	All	2	All	3	All	3	All	3
Depressions (mm)	>20	2	>25	3	>25	3	>25	3
Puddle (area/depth)			>1 m ² >6mm	2			>1 m ² >10mm	3
Loose surface	All	2	All	2	All	3	All	3
Loose kerb	All	2	All	2	All	3	All	3
Missing kerb	All	2	All	2	All	3	All	3

¹ System based on that shown in the Highway Maintenance Handbook.

IL = Intervention level

RT = Response time

Response time codes:

1, within 24 hours,

2, within 2 weeks,

3, within 3 months.

Location categories:

a, main shopping area,

b, busy urban area,

c, less used urban or busy rural area,

d, little used rural footway.

Table A11 Northern Ireland maintenance standards

Footway category	Inspection frequencies	Defect response times			
		Cat 1 (>100mm)	Cat 2 (>50-100mm)	Cat 3 (>20-50mm)	Cat 4 (0-20mm & non surface)
High traffic Town & City centres.	1 month	R1	R1	R2	R4
Medium Traffic Busy urban footways leading from housing estates and car parks to town and city centres. Main streets in villages.	2 months	R1	R2	R3	R4
Low Traffic (high risk) Housing estates with a high incidence of defects due to age of the footway, construction of footway, extensive utility reinstatements or vandalism.					
Low traffic Housing estates, other urban footways and rural footways.	4 months	R1	R2	R3	R4

R1 - Repair or make safe before the end of the next calendar day.

R2 - Repair or make safe within 5 working days.

R3 - Repair within 4 weeks.

R4 - Repair during the next available programme or review condition at next inspection.

Where the footways in an urban estate have been classified as low traffic/high risk, then it will be normal to inspect the associated carriageways at the same interval.

Table A12 Intervention level in footway related reinstatement categories by NRSWA 1991 (DOT et al., 1992)

Category	Allowable tolerance / Intervention level
As-laid profile	Maximum allowable tolerance at the edge of the reinstatement between the levels of the reinstatement and the adjacent surface $\leq \pm 6$ mm.
Edge depression	Intervention is required where the depth of any edge depression > 10 mm over a continuous length of more than 1000mm.
Surface depression	Intervention is required where the depth of any area of surface depression spanning more than 1000mm in any plan dimension exceeds the limits shown in Note below.
Surface crowning	Intervention is required where the height of any area of surface crowning spanning more than 1000mm in any plan dimension exceeds the limits shown in Note below.
Combined defect	The intervention limits shown in note 1 are reduced by 20%, subject to a minimum of 10mm, where edge depression and/or surface depression and/or surface crowning overlap.

Fixed features: kerbstones and related concrete products, channel blocks.

As-laid profile
Maximum allowable tolerance at the edge of the reinstatement between the levels of the reinstatement and the adjacent surface $\leq + 6$ mm. Intervention is required when the mean level of the fixed features does not coincide with the mean level of the immediately adjacent surfaces within a tolerance of ± 10 mm. In the case of a drainage feature the tolerance for intervention level is $+6$ mm to -15 mm.

Intervention limits for surface depression/crowning

Reinstatement width, mm	Intervention limit, mm
Up to 400	10
Over 400 to 500	12
Over 500 to 600	14
Over 600 to 700	17
Over 700 to 800	19
Over 800 to 900	22
Over 900	25

Table A13 Inspection intervals

<i>System</i>	<i>Maintenance inspection</i>	<i>Safety inspection</i>
Old LAA Code of Good Practice (1989)	Cat. I 12 months Cat. II 12 months Cat. III 3 years Cat. IV 5 years	Cat. I 1 month Cat. II 3 months Cat. III 6 months Cat. IV 1 year
Somerset CC (1996)	Cat. 1&2 6 months Cat. 3&4 12 months Cat. 5&6 5 years	Cat.1&2 1 month Cat. 3 3 months Cat. 4&5 12 months Cat. 6 Reactive
Rhondda (2000)		Cat. I 1 month Cat. II 3 months Cat. III 1 year Cat. IV 1 year
Kindred Associations (1998)	In accordance with old LAA Code of Good Practice.	In accordance with old LAA Code of Good Practice.
MARCH (1983)	Condition surveys to be undertaken in accordance with Highway Authority policy.	
TRMM (1996)	Urban 6 months Rural 3 years	Cat. A 7 days & daily safety patrol Cat. B 7 days Cat. C 1 month
CHART (1986)	Condition surveys to be undertaken in accordance with Highway Authority policy.	
DRD(NI) (2000)	1 year	High Traffic 1 month Medium Traffic (and estates with high incidence of defects) 2 months Low Traffic 4 months
UKPMS (2000)	Coarse Visual Inspection (CVI) 1 year Detailed Visual Inspection (DVI) where schemes are proposed. (all depending on extent of UKPMS implementation)	In accordance with Highway Authority policy.
Highway Maintenance Handbook (1997)		Cat. 1 1 week Cat. 2 2 weeks Cat. 3 1 month Cat. 4 3 months Cat. 5&6 1 year
IHT (2000)	Same as Highway Maintenance Handbook.	

Table A14 Response time

<i>System</i>	<i>Categories</i>
Old LAA Code of Practice (1989)	Response time depends on intensity of use and degree of danger.
Somerset CC (1996)	<p>Priority 1 make safe within 24 hours.</p> <p>Priority 2 repair within 28 days.</p> <p>Priority 3 repair within 3 months or during next available programme.</p> <p>Priority 4 review condition at next inspection or repair during next available programme.</p> <p>Priority depends on nature of defect and category of footway.</p> <p>Risk management applied and priority 1 only applied in busiest locations, however some defects on minor roads must be recorded as priority 1 if failure to act would mean first person to pass would be likely to have an accident.</p>
TRMM (1996)	<p>Category 1 make safe, if possible, or protect at time of inspection and make safe within 24 hours, permanent repairs within 28 days.</p> <p>Category 2 repair in programme. Assigned Low, Medium or High priority. Target response for Low 6 months, others assigned by Maintaining Agent.</p>
DRD(NI) (2000)	<p>R1 repair or make safe before end of next calendar day.</p> <p>R2 repair or make safe within 5 working days.</p> <p>R3 Repair within 4 weeks.</p> <p>R4 Repair during next available programme or review condition at next inspection.</p> <p>Response category depends on nature of defect and category of footway (see Table A11).</p>
Highway Maintenance Handbook (1997)	<p>Cat. 1 within 24 hours</p> <p>Cat. 2 within 2 weeks</p> <p>Cat. 3 within 3 months</p> <p>Response category depends on nature of defect and category of footway (see Table A10)</p>

Table A15 Serviceability thresholds

<i>Reference</i>	<i>Serviceability thresholds</i>	
Leake <i>et al.</i> (1991)	Undulation	<10-11 (standard error ¹ , mm) modular paving <14-15 (standard error, mm) bituminous
	Raised edges >5mm	<12% (flags), <9% (small flags)
	Friction (Skid pendulum)	>65
	Broken pavers	<10%
	Gaps >10mm	<1-4%
Highway Maintenance Handbook ² (1997)	Trip or hole (mm)	<10
	Horizontal gap (mm)	<10
	Depressions	<20 mm under 0.5m straightedge
	Rocking flags	None
	Loose surface	None
	Standing water	None

¹ Standard error of estimate of footway heights measured over a 0.5m spaced grid relative to best fit plane.

² Ten year objective.

Table A16 Analysis and prioritisation methods

<i>System</i>	<i>Process between inspection and works</i>
Old LAA Code of Good Practice (1989)	Detailed inspections used in an unspecified way to establish a works programme. Safety inspections direct to immediate or urgent works order.
Somerset CC (1996)	Detailed inspections input to computer system with, if possible, link to works programming and ordering system. Safety inspections direct to immediate or urgent works order.
Kindred Associations (1998)	An adequate system must be employed to establish that the best practicable and reasonable means have been used to rectify liability defects recorded, together with a suitable inspection and repair recording system, e.g. Maintenance Management System or satisfactory system that is less sophisticated.
MARCH (1983)	Rating calculated by computer for those sections where the proportion of the area subject to the defect exceeds an intervention level. Produces priority list of costed maintenance work.
TRMM (1996)	Site data collection is an integral part of the computerised Maintenance Management System that generates and monitors progress on works requirements.
CHART (1986)	Rating calculated by computer from defects recorded which exceed 10 per cent of surface in inner-urban areas and 20 per cent of surface in outer urban and busy rural areas. Assumed intervention maintenance only on little used rural.
DRD(NI) (2000)	Works programme based on assessment of a proposed list of schemes provided by inspectors, other staff, complaints etc. For full details see Table A17. Liability thresholds direct to immediate or urgent works order.
Edinburgh (2000)	For full details see Table A18.
UKPMS (2000)	Under development: data entered into computerised management system. Depending on implementation provides defect rating, overall condition index, treatment selection, performance indicator reports, costing and prioritisation. Liability thresholds should be dealt with urgently in accordance with local intervention system.
Highway Maintenance Handbook (1997)	A deterioration rating is calculated as the sum of ratings of trip incidence, major and minor deterioration (based on 'MARCH' defects) and additional factors (complaints, accidents and rechargeable and complementary works) multiplied by a location weighting. Prioritisation includes consideration of costs. For full details see Section 4.6.9 of the Highway Maintenance Handbook.

Table A17 Procedures for assesment of proposed footway schemes (Belfast South)

Procedure for resurfacing footway for it's own specific needs¹

Step 1

A list of proposed schemes is provided by inspectors, other staff, commitments or complaints from the general public etc.

Step 2

A visual assessment is carried out on a pro-forma and each street is given a general prioritisation. Ratings are summarised as follows:

Evenness	1 = Acceptable, 2 = Poor, 3 = Bad, 4 = Serious
Ponding	ditto
Crazing	ditto
Deterioration	ditto
Binder loss	ditto
Fatted up	ditto
Patching	<50% or >50%
Kerb show	<50mm, 50-100mm, >100mm
Backfall	Required or not
Override	Light, Heavy

Step 3

The following criteria are considered before re-prioritising list from item 2:
Maintenance history of street/road.

Does existing carriageway require resurfacing?

Are there any work schemes proposed, re-alignment etc?

Financial priority, cost implication and Value For Money.

Level of public liability claims in the area.

Volume of pedestrian traffic.

Nature of pedestrian traffic e.g. disabled, visually impaired, elderly etc.

Utility involvement/proposals for the street/road.

Roads Services policies in relation to, the replacement of flags with asphalt, construction requirements due to vehicle over-ride, surface type restriction within conservation areas, tree root damage limitation/repair etc.

Step 4

A final resurfacing list is then produced utilising available financial resources.

¹ *Some footway works are unavoidably generated by the requirement for structural overlay to carriageways.*

Table A18 Prioritising footway schemes (Edinburgh)

A list of maintenance schemes is prepared from local knowledge, information supplied by a telephone response service and complaints/comments from members of the public. The schemes are evaluated and prioritised on standard sheets using the following rating system.

<i>Feature</i>	<i>Rating</i>	<i>Description</i>
Point 1		
Kerb upstand	0	Upstand 110-100mm
	1	Upstand 100- 70mm
	2	Upstand 70- 40mm
	3	Upstand 40- 0mm.
Point 2		
Kerb deterioration & alignment	0	New looking kerbs, no unnecessary rise and fall, no trips.
	1	Slightly chipped edges/missing corners, slight rising of few kerbs, occasional trips.
	2	Some kerbs may be cracked/spalled, rising of kerbs causing major trips.
	3	Missing kerbs/major deterioration, rising of kerbs liable to cause injury.
Point 3		
Footpath/ footway deformation	0	Completely flat.
	1	Slight undulation of surface.
	2	More serious movement in the surface.
	3	Undulation severe, causing difficulty walking.
Point 4		
Footpath/ footway deterioration	0	New looking surface, no material loss.
	1	Slight material loss or damage to flags.
	2	Approx. 25% material loss, broken flags.
	3	Serious material loss, missing flags, etc. liable to cause injury.
Point 5		
Surface water	0	No standing water.
	1	0-10% of surface covered with shallow pools of standing water.
	2	10-40% ditto
	3	Greater than 40% of surface with major water problems.
Point 6		
Deterioration beyond cyclic maintenance levels	0	Very good condition, probably more than 10 years residual life.
	1	Good condition, probably 5-10 years residual life.
	2	Still in good condition, starting to wear in areas but still probably 5-7 years residual life.
	3	Reasonable condition, wear and tear starting to show, probably 2-5 years residual life.
	4	Poor condition, giving pedestrians difficulties, requires maintenance in the next 2 years.
	5	Requires maintenance urgently.
Point 7		
Will exclusion of scheme cause danger?	0	Definitely no increase in danger.
	1	No increase in danger levels should be expected.
	2	Slight possibility of rise in minor injuries to pedestrians.
	3	Possibility of rise in more serious injuries to pedestrians.
	4	High risk of injury to pedestrians.
	5	Too dangerous to be excluded from the maintenance list for this year.
Point 8		
Priority rating	Varies 1.1 to 2	The importance of the footway is rated according to the usage and category, e.g. very busy shopping area 2.0, and quiet cul-de-sac 1.1.
Point 9		
Amenity rating	Varies 1 to 5	The amenities in the area that are likely to cause high pedestrian movement are rated, e.g. modernisation, clinics, mobility impaired, schools, and elderly people.
Point 10		
Total rating		This is the sum of points 1 –7, multiplied by point 8, added to point 9.

Appendix B: Blank proforma for local authority use

(Note: the levels in *italics* are provisional TRL guidelines, for further details see Tables 7 and 8 in Section 7 of the report.)

Maintenance investigation thresholds

<i>Footway category</i>	<i>Defective area TRL guidelines</i>	<i>Threshold TRL guidelines</i>
1 and 1a	<i>Local deterioration or discomfort to walking, areas of temporary repairs</i>	<i>5 to 15 per cent</i>
2		
3	<i>Deterioration or discomfort to walking, areas of temporary repairs</i>	<i>15 to 30 per cent</i>
4		

Maintenance treatment levels

<i>Defect TRL guidelines</i>	<i>Threshold TRL guidelines</i>
<i>Coarse cracking</i>	<i>>2mm wide</i>
<i>Coarse crazing</i>	<i>>2mm wide</i>
<i>Loss of material, scabbing or fretting of stone from surface</i>	
<i>Areas of undulation, depressions or bumps¹</i>	<i>>25mm in 500mm</i>
<i>Vertical projections (trips)</i>	<i>>10mm</i>
<i>Areas of temporary repairs, reports of hazards, history of defects</i>	<i>From records</i>
<i>Slippery surface²</i>	

Flags or blocks

<i>Vertical projections (trips)</i>	<i>>10mm</i>
<i>Missing flags or blocks</i>	
<i>Rocking flags</i>	
<i>Areas of undulation, depressions or bumps¹</i>	<i>>25mm in 500mm</i>
<i>Cracks or gaps</i>	<i>>20mm wide</i>
<i>Areas of temporary repairs, reports of hazards, history of defects</i>	<i>From records</i>
<i>Slippery surface²</i>	

¹ Might cause stumbles and trips, uncomfortable for walking, or contain standing water.

² It is considered that slipperiness be defined by inspectors, as it is thought impractical to use measuring devices on a routine basis at present.

(Note: the levels in *italics* are provisional TRL guidelines, for further details see Table 5 in Section 6 of the report)

Safety investigatory levels and response times

<i>Defect</i>	<i>Investigatory level</i>	<i>Response time code</i>			
		<i>Footway category</i>			
		<i>1 and 1a</i>	<i>2</i>	<i>3</i>	<i>4</i>
<i>TRL guide</i>	<i>TRL</i>	<i>TRL</i>	<i>TRL</i>	<i>TRL</i>	
Vertical projections (trips)	>20mm	<i>H</i>	<i>M</i>	<i>L</i>	<i>L</i>
	>50	<i>Cat 1</i>	<i>H</i>	<i>M</i>	<i>M</i>
	>100	<i>Cat 1</i>	<i>Cat 1</i>	<i>H</i>	<i>H</i>
Depressions, humps, potholes and missing slabs	>25mm	<i>H</i>	<i>M</i>	<i>L</i>	<i>L</i>
	>50	<i>Cat 1</i>	<i>H</i>	<i>M</i>	<i>M</i>
	>100	<i>Cat 1</i>	<i>Cat 1</i>	<i>H</i>	<i>H</i>
Crack or gap (mm) (>20mm depth)	>25mm	<i>H</i>	<i>M</i>	<i>L</i>	<i>L</i>
Rocking slabs and ironwork	<i>As above, although all can be dangerous</i>				
Missing kerb	<i>All</i>	<i>H</i>	<i>H</i>	<i>M</i>	<i>L</i>
Loose or damaged kerbs	<i>Projection, deflection, crack or gap</i>				
Low kerbs – height	>75mm	<i>M</i>	<i>L</i>	<i>L</i>	<i>L</i>
Ironwork	<i>Cracked</i>	<i>H</i>	<i>H</i>	<i>H</i>	<i>M</i>
	<i>Badly damaged</i>	<i>Cat 1</i>	<i>Cat 1</i>	<i>Cat 1</i>	<i>Cat 1</i>
Miscellaneous hazards	<i>See notes below</i>				

Miscellaneous hazards: Category 1 defects include for example missing access covers or fallen trees.

Category 2 defects include for example, unsafe signing, lighting or guarding of excavations (notify contractor), unsafe steps, slippery surfaces, standing water deflecting pedestrians into carriageway, standing water when freezing anticipated, persistent snow and ice or leaves on surface and loose surface.

Response depends on intensity of use and degree of danger.

Response codes:

Cat 1 - Make safe or repair within 24 hrs.

H (Cat 2) - Make safe or repair within 5 working days.

M (Cat 2) - Repair within 4 weeks.

L (Cat 2) - Repair during next available programme, schedule more detailed inspection, or review condition at next inspection. Target: repair within six months.

(Note: The levels in *italics* are provisional TRL guidelines, for further details see Table 9 in Section 8 of the report)

Serviceability investigation thresholds

Defect description (TRL guidelines)		Threshold level			
		Proposed footway category			
		<i>1 and 1a</i>	<i>2</i>	<i>3</i>	<i>4</i>
		TRL	TRL	TRL	TRL
Uneven surfaces	Depth/height (mm)	>10	>10	>15	>20
	Dimension (m)	1.0	0.6	0.6	0.6
	No. per 100m	5	5	10	20
Potholes	Depth (mm)	>10	>10	>15	>25
	Width (m)	<0.6	<0.6	<0.6	<0.6
	No. per 100m	1	2	3	5
Projections (trips)	Height (mm)	>10	>10	>15	>20
	No. per 100m	5	5	10	20
Areas of cracking, crazing and patching	Crack width (mm)	>10	>10	>10	>10
	Percentage area affected per 100m	10%	15%	20%	30%
Rocking slabs and ironwork - deflection	Height (mm)	>10	>10	>15	>20
	No. per 100m	5	5	10	20
Standing water	Area (m ²)	>0.25	>0.5	>0.5	>1
	Usable footway width (m)	<2	<2	<1.5	<1
	No. per 100m	1	2	3	5
	Reduced capacity		Deflects pedestrians into carriageway		
Standing water in carriageway	No. per 100m	1	2	3	5
			Splashes onto footway and pedestrians		
Damaged kerbs	% of length per 100m	5%	5%	10%	20%
Inadequate kerb upstand	% length per 100m	5%	10%	10%	20%
	Height ^a (mm)	<75	<75	<75	<75
Slippery surfaces ^b					
Loose stones	Extent of damage % of surface	5%	5%	10%	20%

a Except protected kerbs, or where low kerbs are provided by policy

b It is considered that slipperiness be defined by inspectors, as it is thought impractical to use measuring devices on a routine basis at present.

Abstract

This report reviews and investigates current threshold levels with the aim of establishing levels for maintenance investigation. These cannot be viewed in isolation from other procedures that each Highway Authority will have in place. Therefore, the report also examines the overall maintenance system. The objectives of footway maintenance are to provide a safe environment, to prevent deterioration, and to provide a satisfactory surface quality to encourage walking. There are benefits in planned and timely preventative maintenance. However with funds for maintenance limited, many Highway Authorities are not able to carry out inspections for maintenance on a systematic basis, let alone undertake maintenance improvement schemes. A staged process of inspection is proposed which provides the basis for prioritising funds and identifying the need for increased funding. The process consists firstly of the selection of schemes based on information to hand, supplemented where necessary by a coarse type of inspection, secondly the further selection based on a detailed inspection, and thirdly the prioritisation and selection of treatment type. Three different threshold levels are proposed: safety, maintenance and serviceability; provisional thresholds are proposed based on a study of current standards and other available literature.

Related publications

- TRL534 *Condition indicators in footway maintenance* by M Zohrabi, P L Scott, S Bird, and D R Cooper. 2002 (price £25, code E)
- TRL134 *A study of footway maintenance edited* by M H Burtwell. 1995 (price £20, code C)
- PR95 *Footway maintenance, Part 1: a review of profile monitoring techniques* by C C Spong. 1994 (price £20)
- PR96 *Footway maintenance, Part 2: an assessment of profile monitoring equipment* by C C Spong and D R C Cooper. 1994 (price £20)
- PR97 *Footway maintenance, Part 3: footway profilometer end product/performance specification* by C C Spong and D R C Cooper. 1994 (price £20)
- AG26 *Footways design and maintenance guide. Part 1: new construction. Part 2: maintenance.* 1997 (price £50, code P)

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