VOLUME 7 PAVEMENT DESIGN AND MAINTENANCE
SECTION 4 PAVEMENT MAINTENANCE METHODS

PART 3

HD 40/01

FOOTWAY MAINTENANCE

SUMMARY

This part provides guidance on footway maintenance. It provides advise on inspection of footways, the likely causes of defects and the possible treatment options that are available.

INSTRUCTIONS FOR USE

This is a new document to be incorporated in the Manual.

1. Insert HD 40/01 into Volume 7, Section 4, Part 3.

2. Archive this sheet as appropriate.

Note: A quarterly index with a full set of Volume Contents Pages is available separately from The Stationery Office Ltd.

THE HIGHWAYS AGENCY

SCOTTISH EXECUTIVE DEVELOPMENT DEPARTMENT

THE NATIONAL ASSEMBLY FOR WALES
CYNULLIAD CENEDLAETHOL CYMRU

THE DEPARTMENT FOR REGIONAL DEVELOPMENT*

Footway Maintenance

* A Government Department in Northern Ireland

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REGISTRATION OF AMENDMENTS

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Contents

Chapter

1. INTRODUCTION

General

1.1 This part provides guidance on footway maintenance to ensure that the surface and structure of the footway provides safe passage by day and night for pedestrians, including those with mobility difficulties.

1.2 Footways deteriorate in a variety of ways, depending upon the cause of distress and the type of construction. In some cases timely maintenance may prevent general deterioration, due to ageing and permeability, from progressing to a state where reconstruction becomes necessary. Some features of distress are indicative of structural failure and any maintenance treatment will need to take this into account. If the deterioration presents a safety hazard to users then maintenance becomes essential. The appropriate response time will depend on the risk of an incident occurring. It is outside the scope of this Part to specify intervention levels and response times.

1.3 Regular inspections are necessary to monitor the condition of the footway so that any defects can be rectified. The maintenance treatment adopted should depend not only on the type of defect, its severity and extent, but also on the mechanism that has resulted in the defect. In many instances it will be sufficient to treat the symptom(s) of footway distress by repairing the surfacing. However, if it is suspected that the footway construction is failing at depth, a site investigation may be required to assess the causes and depth of the failure. An informed engineering judgement can then be made about the strategy to be adopted.

1.4 For one particular mode of failure, that caused by frequent overrun of vehicles, treating the symptom only will lead to recurrence of failure. Consideration should first be given to re-designing the traffic management of the area so as to prevent future vehicle overrun. If this is not possible, the maintenance strategy should be reconstruction using the designs given in HD 39 (DMRB 7.2.5) for light or heavy-vehicle use as appropriate.

1.5 The other major consideration before a maintenance strategy is adopted is to decide whether the maintenance treatment should be carried out using the same material type as that of the failed footway. If a change in material type is required (eg. for aesthetic reasons) then the guidelines given in HD 39 (DMRB 7.2.5) should be followed. This may necessitate a full reconstruction.

1.6 A series of worked examples are provided in Annex D of this Part to demonstrate the use of the techniques and flow-charts.

Implementation

1.7 This Part shal be used forthwith on all schemes for the construction, improvement and maintenance of trunk roads including motorways currently being prepared, provided that, in the opinion of the Overseeing Organisation this would not result in significant additional expense or delay. Design organisations should confirm its application to particular schemes with the Overseeing Organisation.

Mutual Recognition

1.8 Where Parts of Volume 7 give the Overseeing Organisation's requirements for products, they make provision for the acceptance of equivalent products from other member states of the European Community. Reference should be made to the statement in each Part concerned.

2. INSPECTION METHODS

Introduction

2.1 Regular inspections are necessary to monitor the condition of the footway network so that any defects can be identified and rectified. The Local Authorities Association Code of Good Practice (LAA, 1989) considers that two levels of inspection are sufficient for footways (**safety** and **detailed**) and gives warning and intervention levels for recorded defects. Refer to the Overseeing Organisation for their maintenance policy, setting out the inspection frequencies, intervention levels and response times. Taking responsibility for and adhering to a sensible maintenance policy can reduce insurance premiums and litigation claims.

2.2 There are various Codes of Practice and systems available giving details of defects to note, inspection frequencies and response times. Examples are:

- LAA Code of Good Practice
- MARCH (Maintenance Assessment, Rating and Costing for Highways)
- CHART (Computerised Highway Assessment of Ratings and Treatments)
- Trunk Road Maintenance Manual: Routine and Winter Maintenance Code
- UKPMS Pavement Management System and visual inspection guide

There are also a number of proprietary systems available. CHART is primarily intended for the management of trunk roads and is less applicable to footways. Table 2.1 summarises the frequencies of inspections currently recommended in the LAA Code of Good Practice which relate to the use of the footway. For Northern Ireland, inspection frequencies are detailed in Table 2 of Roads Service's Policy and Procedures Guide RSPPG_019.

2.3 **Safety inspections** should note all defects that are a hazard, such as trips, potholes, broken flags, rocking flags, missing pavers or flags, ruts or depressions. Safety inspections provide evidence that the authority takes a responsible attitude to its duties under the Highway Act 1980 (or The Roads (NI) Order 1993 in Northern Ireland) and inspection records form the core of defence against claims.

Category	Type of Footway	Inspection Frequency for Category Shown	
		Detailed	Safety
1	Pedestrian precincts	12 months	1 week
1	Main shopping areas	12 months	1 month
2	Busy urban areas	12 months	3 months
3	Less used urban and busy rural	3 years	6 months
4	Little used rural	5 years	1 year

Table 2.1 Frequency of Inspections

2.4 **Detailed inspections or condition surveys** should be carried out using a standardised system. In addition to the factors that are noted in safety inspections, other defects such as fretting, irregularities caused by plant growth, slipperiness and water seepage or pumping should be noted. The inspections can be used as a basis for assessing the current state and condition trends of the footway network. They help to identify the structural maintenance required and enable the engineer to prioritise maintenance in order to spend the budget more effectively.

2.5 In maintenance management systems all defects normally have warning and intervention levels and associated response times that vary according to the footway usage. A complaint received from a member of the public should initiate a very quick response.

3. CAUSES OF DEFECTS

Introduction

3.1 The remedial treatment for a footway will not only depend on the defect but also on the cause of that defect. Surface deterioration that has no underlying structural cause can be remedied by replacement or overlaying of the surface. If not treated, surface deterioration may allow the ingress of water, which can then lead to structural deterioration. If surface distress is the result of a problem at depth it may not be cost effective to merely repair the surface, as the defect is likely to recur.

3.2 A visual condition assessment should enable a shortlist of likely causes of defects to be drawn up. However, the cause may no longer be evident, eg. if it was caused by flooding or the diversion of traffic due to a nearby accident. Investigation of the history of the footway, with respect to its construction, maintenance and rehabilitation, should provide further information.

3.3 To help establish the cause of the defect, inspections should note:

- Drainage
- Kerb and channel condition
- Trees - size and type
- Nature of use - pedestrian only, light-vehicle overrun, heavy-vehicle overrun
- Undertakers' apparatus

3.4 The cause of primary distress may be difficult to ascertain, particularly in cases where a number of distress mechanisms are evident. It may be difficult to decide whether rutting has resulted from cracking combined with the ingress of water and trafficking, or whether the footway is of structurally unsound design and the deformation has led to cracking of the surface. It may be necessary to dig a trial hole to check layer thicknesses, material condition and drainage adequacy. Care should be taken to avoid all underground apparatus.

CAUSES OF DETERIORATION

3.5 Some possible causes of deterioration in footways and footway materials are listed in Table 3.1. Many of these could be avoided by careful planning and supervision of footway construction and maintenance.

Cause of Deterioration	Features
Poor specification and design	Inadequate thickness, edge restraint, drainage or frost protection
Faulty construction	Incorrect materials or methods leading to inadequate layer thickness, poor surface regularity or inadequate compaction
Abuse	Poor trench reinstatement leads to settlement or unevenness, weakening of the structure, loss of interlock on modular surfaces. Vehicle overrun leads to over-stressing materials and/or the foundation and hence structural failure
Weathering	Ageing leads to hardening of bitumen. Freeze/thaw cycles cause surface deterioration. Clay shrinkage or swelling causes ground movement.
Damage by vegetation	Weeds and tree roots cause surface unevenness.
Fair wear and tear	Heavy usage causes loss of surface texture and fretting.
User perceived failure	Spalling, cracking, poorly matched materials, etc. lead to an unacceptable appearance

Table 3.1 Causes of Deterioration

Poor Specification and Design

3.6 The footway may fail because it has not been designed to withstand the loadings to which it is subjected or because the specified layer thicknesses are insufficient to provide protection to a frost susceptible subgrade. Insufficient attention may have been paid to the risk of vehicle overrun, or the use of the footway has changed since it was built. Inadequate parking facilities may lead to an increase in overrun as car ownership increases.

Faulty Construction

3.7 Deterioration may be due to substandard or incorrect materials or to non-compliance with specified levels or tolerances. Better education and supervision of the work force would reduce the deterioration due to faulty construction.

3.8 Inadequate compaction is a common problem in footways because of the restricted space, the small rollers used and the short workability time of thin layers of bituminous materials. Powell and Leech (1983) showed that a three per cent reduction in the void content of bituminous materials markedly increases the structural performance of pavements.

Abuse

3.9 Non compliance of trench reinstatements with the Code of Practice Specification (DOT et al, 1992), commonly known as the HAUC Specification, issued under the New Roads and Street Works Act 1991, may cause deterioration of the footway surface or of the structure at greater depth. (In NI the NIRAUC Specification, issued under the Street Works (NI) Order 1995 applies). Overrun is also a form of abuse, and heavy vehicle overrun (such as might occur due to building development), is particularly damaging, as are the feet of skip lorries. Spillage of diesel fuel can cause softening of bitumen and loss of aggregate from a flexible surface.

Weathering

3.10 A dense, well compacted bituminous material is less susceptible to the detrimental effects of weathering than a less dense material with more air voids. Surface fretting and spalling due to freeze/thaw cycles is unlikely to be a problem for precast concrete and clay products manufactured in accordance with appropriate standards. Natural stone products with high water absorption levels are more susceptible.

Fair Wear and Tear

3.11 Loss of surface texture due to normal foot or cycle traffic cannot be eliminated, but it can be reduced to an acceptable level by using the appropriate materials for the wear properties required. If the material is well suited for its situation the loss of texture due to wear can be balanced by increase in texture due to surface weathering.

Damage by Vegetation

3.12 Damage by tree roots occurs where trees are sited too close to footways (or vice versa) and where the roots are spreading rather than deep. Correct siting, planting and choice of tree species would avoid the situation. Damage by weed growth occurs most frequently on little used footways; pedestrian traffic generally destroys weeds soon after germination. Weed infestation takes advantage of pre-existing damage such as cracks and gaps, so treatment of surface defects can help prevent weed growth.

User Perceived Failure

3.13 Care taken in reinstatement and choosing widely available varieties of modular surfacing, such that sufficient stocks of replacement modules to match can be kept, should limit user perceived failure. On bituminous footways an application of slurry seal can restore the surface appearance. If there is no hazard and the structural performance of the footway is not affected, then no action is needed.

DISTRESS MODES

3.14 The typical distress modes which result from these causes of deterioration are listed in Table 3.2 for the three generic types of surface. A detailed description, including photographs, is provided in Annex A of the Part.

Bituminous	Modular (Pavers and Flags)	Concrete
Block cracking Depressions and bumps Linear cracking Loss of surface aggregate Potholes Structural Rutting (sub-grade failure) Non-structural rutting (material deformation)	Broken/cracked modules Depressions and bumps Missing modules Rocking flags Spalling of arises or surface Widening of joints Rutting (Pavers) Unzipping (Pavers)	Cracking Damaged joints Depressions and bumps Surface failure

Table 3.2 Distress Modes for Surface Types

SURFACE DETERIORATION

Bituminous Surfaces

3.15 One reason for deterioration of bituminous surfaces is ageing due to oxidation. This process will be accelerated if good compaction is not achieved and there are high air voids in the bituminous material. As the bitumen ages surface cracking or fretting may develop with eventual formation of potholes. Potholes frequently result from a small defect being worsened by the infiltration of water into the base material.

3.16 Stripping of binder from the aggregate will also lead to surface deterioration. Stripping may occur because the bitumen has become brittle with age; the aggregate has deteriorated; insufficient bitumen was used in the mix; or absorption of bitumen into the aggregate has taken place. The process of stripping is hastened by the presence of water in the voids. Stripping which occurs soon after construction may be due to insufficient bitumen in the mix; poor adhesion of bitumen to stone due to wet, dusty or water attracting aggregate; or to cold or wet weather at the time of construction.

3.17 Surface deterioration due to delamination may result from poor cleaning or insufficient bond coat prior to placing the new surfacing. Cracking of the bituminous surfacing may be a result of ageing of the surface or may indicate structural problems. Longitudinal cracks may result from insufficient edge restraint allowing the footway to spread, or from shrinkage of clay subgrades. Cracks can also arise at joints, leading to ingress of water and deterioration. Reflective cracking can occur on footways with a lean concrete base.

Modular Surfaces

3.18 A rocking module indicates displacement or loss of the bedding sand which may be caused by ingress of water as a result of joint failure. This can be due to lack of edge restraint and opening of joints as the footway spreads, or to removal of jointing sand by suction cleaners. Cracked modules are usually the result of point loads or traffic loading of modules which have insufficient tensile strength to resist the applied loading. Rocking or cracked modules may result in trips.

3.19 Loss of material from the exposed surface of a module or surface spalling, may be due to a manufacturing defect, impact loading, abrasion, weathering or chemical attack. Heavy trafficking of modules by pedestrians may cause loss of slip resistance. Vehicular trafficking of modules set in mortar may break the bond and loosen the module.

Concrete Surfaces

3.20 Concrete surfaces can become roughened because of loss of the cement paste due to acid attack or sulphate attack. This can also apply to the surfaces of concrete pavers or flags. Frost attack may cause scaling and delamination of poor quality concrete. Air entrained concrete is resistant to frost attack.

3.21 Cracks in concrete footways may be due to insufficient thickness of slab, shrinkage, low concrete strength or inadequate compaction, loss of support and settlement, natural weathering, temperature changes and freeze/thaw cycles. If the cracked concrete is providing adequate load spreading to the underlying foundation the cracking can be considered as surface deterioration, otherwise reconstruction is required.

STRUCTURAL DETERIORATION

3.22 Structural deterioration occurs when the footway construction has insufficient strength to support the loading to which it is subjected. This may be because of abuse, such as vehicle overrun on a footway not designed to support overrun; poorly reinstated undertakers' trenching works; or weakening of the construction due to drainage failure or material failure.

Overrun

3.23 In a footway designed for pedestrian-only usage, overrun causes over-stressing of the footway surfacing and the foundation since the construction has insufficient strength to support the loading. This is likely to lead to rutting and/or tilting kerbs. On footways, overrun may be associated with cracking in bituminous or concrete surfaces where there is inadequate thickness for the loading. The cracking then increases the ingress of water and leads to softening of unbound layers which accelerates the rut formation.

Statutory Undertakers' Works

3.24 Long narrow depressions are usually a sign of failure in an statutory undertaker's trench and are often accompanied by cracks and steps along the edges of the depressions. Local depressions may also indicate failure of a reinstatement. Depressions may be the result of settlement due to poor compaction or volume change of subgrade materials. Surface crowning or heave may be due to poor reinstatement of trenches or to ground movement caused by water ingress.

Subgrade Moisture

3.25 Drainage is a critical factor and, if it fails to perform, structural damage often ensues. As a general rule, it is preferable to remove surface water to the adjacent carriageway where it will be dealt with in conjunction with carriageway drainage.

3.26 Tree roots can cause considerable damage. By extracting water from the subgrade in periods of dry weather, the roots can cause the subgrade soil to shrink, particularly where the soil is an expansive clay. This will cause the footway surface to deform. Widening of joints in modular paving may be indicative of ground movement.

Cracking

3.27 Mosaic cracking (crazing) of a bituminous surface may be the result of excessive deflections due to lack of support from underlying materials, or to embrittlement of the bituminous material. Cracking may also be due to poor quality material. Reflective cracks may be caused by shrinkage or other movement in the base (especially if cement bound), sub-base or subgrade.

3.28 Cracking of modular paving may be due to the foundation layers providing insufficient support. The larger and thinner the flags, the larger the warping and traffic induced stresses. Note that a stabilised bed will not provide adequate support to a warped flag.

4. TREATMENT OPTIONS

Introduction

4.1 The treatment options will depend upon the severity and extent of the defect, the consequences of leaving it untreated, the hazard presented and the available budget. Consideration should also be given to the amenity value of the area. Tables 4.1 to 4.5 summarise the range of treatment options for temporary and long-term works. 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 future use
- Mechanism of deterioration
- Risk factors such as overrun
- Range of material options
- Recycling possibilities

Temporary, Urgent or Short-term Works

4.2 Temporary, urgent or short-term treatments cannot always be expected to remain in place for more than 1 year. The need for an urgent treatment may result from a report, complaint, safety inspection or an emergency such as a chemical or fuel spillage. The objective is to make safe and to protect the public until the long-term treatment has been effected. Defects which may be identified as requiring emergency treatment are significant trips, depressions, bumps, cracks, potholes, missing modular units or contamination. Urgent treatment will depend on the severity and, to some extent, on the cause. A maintaining authority will normally have a maintenance policy statement in which the response period to those defects which constitute a hazard and require emergency treatment will be defined.

4.3 If it is not possible to eliminate the defect in the short term, then pedestrians should be warned of the defect by barriers being placed around it. This may be the case, for example, when trips are caused by tree roots and the remedy may involve raising the surface of the footway, root pruning or removal of the tree; processes which need some time to carry out. If root pruning is considered, advice should be sought from an arboriculturist.

4.4 Trips in modular footways should be dealt with by lifting and replacing the offending modules. Bituminous material can be used as a temporary replacement in order to remove the hazard in the short term but “unzipping” of modules will occur if it is left in place for too long. Depressions can also be taken out using a bituminous mixture, and surface unevenness on concrete footways can be regulated in the same manner. An alternative is to use cement bound material. Replacement of surfacing modules using temporary materials is occasionally necessary because replacement modules are unavailable or the isolated replacement of small quantities of modular surfacing is uneconomic. Any interim surfacing should provide similar comfort levels for pedestrian traffic as the normal surfacing modules.

4.5 In footways surfaced with bituminous material it is better to patch the footway than merely to fill a pothole, as infill material is unlikely to be durable. Guidance on patching is provided in Chapter 5 of this Part.

Long-term Treatments

4.6 Sealing bituminous footways prevents further surface deterioration such as formation of potholes, fretting or stripping of aggregate from the surface, and restores slip resistance (although a slippery surface may just need cleaning). Stripping needs to be treated promptly as the footway surface can deteriorate rapidly. Sealing the surface will also reduce the infiltration of water into the pavement and may thus reduce the rate of development of rutting and depressions. Slurry surfacing restricts the rate of infiltration of water into pavements better than a thin asphalt overlay.

4.7 Sealing or replacing the surface may be the appropriate action for mosaic cracking (crazing), if there is no associated deformation resulting from structural weakness. Depressions or ruts in bituminous footways can be removed by resurfacing whilst, in modular footways, the modules will need to be lifted and relaid. However, if the depressions or ruts are caused by weakness in the formation, or by footway under-design, the problem is likely to recur unless in-depth repairs are performed. If rutting is due to ingress of water and weakening of the subgrade, the provision of subsoil drainage may solve the problem. (Surface and structural repairs are described in Chapter 5 of this Part).

4.8 Broken and uneven large flags adjacent to the kerb, resulting from vehicle overrun, can be replaced by in-situ concrete or bituminous material until such time as the whole footway can be resurfaced. Concrete footways with uneven joints may have their life extended by grinding off the "lips" to restore safety (ie trips on very large slabs).

4.9 Deformation which continues to occur after surface treatment has been carried out needs to be examined in more detail. Where deformation is caused by tree roots, a root barrier should be installed if possible. Where deformation is the result of overrun, reference should be made to HD 39 (DMRB 7.2.5) so that the footway can be reconstructed with the appropriate layer thicknesses and materials for the situation. Alternatively, some means of preventing the overrun may be employed.

Consequences of Not Treating Defects

4.10 If defects are not treated there are consequences both for the user and for the footway itself. Defects in the surface condition of a footway will cause pedestrian inconvenience. If these defects have been identified by safety inspections as being potentially hazardous to the user, then not treating them within a reasonable time will make it difficult to defend any subsequent claims made by pedestrians. Even defects which do not present an immediate safety hazard may do so in the future. (An example of this would be a depression with standing water, insufficient to cause a safety hazard itself, but which may become one if freezing conditions prevail). The surface condition is the most important characteristic applying to pedestrian safety and comfort.

4.11 The judgement of the inspector, reflecting the maintenance policies of the authority, must be exercised in deciding when to treat defects. As far as the footway itself is concerned, the treatment required is likely to be easier to carry out and less costly if the defect is repaired before major deterioration has occurred. Sealing the surface of a bituminous footway with slurry surfacing, while fretting or cracking is minor, will delay further deterioration. Not sealing an aged bituminous surfacing may lead to serious fretting, potholes forming and the need for resurfacing or even reconstruction.

4.12 Where there is minor cracking (a single crack), with no other associated defects discernible, no maintenance action is required unless a good reason exists to seal the crack - such as to prevent infiltration to a water sensitive material below. However, weeds may grow in the detritus that collects in unsealed cracks making them unsightly and causing them to widen. Damage may also be caused by water freezing in cracks and expanding, thus enlarging the cracks.

4.13 In modular footways, any unevenness or rocking modules will worsen if left untreated, since debris gets into gaps and uneven load spreading by the modules causes greater localised stress on the underlying foundation which may consequently deform.

Defect	Problem	Treatments	
		Temporary	Long-term
Depressions & bumps	Hazard for users	Fill or ramp. Contact Statutory Undertaker if cause is failed reinstatement.	Reshape surfacing
Rutting	Hazard for users	Fill	Reshape surfacing. Prevent overrun or reconstruct if necessary
Slippery surface	Hazard for users	Warn users or restore texture	Clean, restore texture or renew surfacing
Surface contamination	Hazardous	Clean or neutralise	Replace surfacing if necessary
	Unsightly	-	Clean
Vegetation	Tree roots cause trips	Warn users or ramp	Reshape surfacing. Consider replacing trees with a more suitable variety
	Vegetation obstructs footway	Trim growth	Consider increasing frequency of maintenance
	Surface slippery	Warn users and clean	
Water	Surface water	Salt, if freezing	Reshape surfacing to correct gradients and crossfalls.
	Blocked drainage	Clear blockage	Rectify any damage caused
	Burst mains	Inform Statutory Undertaker and make safe	

Reshape = relay modular paving, replace bituminous wearing course (and basecourse) or overlay with new wearing course, overlay with thick slurry seal or use Retread (refer to Chapter 5 of this Part).

Table 4.1 Treatments Common to all Types of Footway Surfacing

Note for Tables 4.1 - 4.5: Temporary, includes urgent or short-term works eg to remove a hazard. Further treatment shown under “long-term” may also be required.

Defect	Problem	Treatments	
		Temporary	Long-term
Mosaic cracking	Embrittled surfacing	-	Seal or replace surfacing
	Structural failure	-	Replace surfacing. Reconstruct if problem recurs
Linear cracking	Water ingress, trips	-	Seal, replace surfacing or reconstruct if necessary
Loss of surface aggregate	Loose or uneven surface	-	Seal or replace surfacing
Potholes	Trips, water ingress	Fill	Patch or replace surfacing

Table 4.2 Treatments: Bituminous Surfacing

Defect	Problem	Treatments	
		Temporary	Long-term
Broken or damaged modules	Unsightly appearance, water ingress	-	Replace damaged modules, re-surface or reconstruct if problem is due to overrun
Loss of jointing material	Water ingress, modules can move/ rotate	-	Replace jointing material, seal joints
Missing modules	Holes, trips	Fill holes	Replace modules
Rocking modules	Hazard to users	Relay modules	Reconstruct if problem is due to overrun
Spalling of arrises or surfaces	Unsightly appearance	-	Replace damaged modules
Trips	Hazard to users	Relay modules	Reconstruct if problem is due to overrun
Widening of joints	Water ingress, modules can move/rotate	Fill wide gaps if a hazard	Relay surfacing and provide edge restraint if necessary

Note: When relaying modular surfacing it is preferable to relay the whole area between edge restraints.

Table 4.3 Treatments: Modular Surfacing

Defect	Problem	Treatments	
		Temporary	Long-term
Damaged joints	Spalling, cracking, water ingress	-	Seal cracks. Overlay or replace joints and/or concrete
Cracking	Unsightly, water ingress	-	Seal cracks. Overlay or reconstruct
Weathering	Scaling, delamination, aggregate exposure	-	Overlay or reconstruct
Corrosion of steel	Cracking, rust	-	Seal cracks. Reconstruct
Trips	Hazard for users	Ramp or feather	Overlay or reconstruct

Table 4.4 Treatments: Concrete Surfacing

Defect	Problem	Treatments	
		Temporary	Long-term
Damaged or missing item	Loss of edge support	-	Replace kerb or edging
Horizontal or vertical steps	Hazard for road users and/or pedestrians	Relay item	Seal cracks. Overlay or reconstruct
Poor channel alignment, delamination, aggregate exposure	Drainage not functioning properly	-	Relay or replace kerb or edging
Vegetation	Water run-off prevented	Remove vegetation, apply weedkiller	Increase vegetation control frequency
Trips	Hazard for users	Relay item	Replace kerb or edging

Table 4.5 Treatments: Kerbs and Edging

4.14 Depressions or rutting caused by overrun are likely to worsen if untreated, particularly if the subgrade is soft.

Defect Category and Response Time

4.15 The same defect may be assigned a different response time according to its location and footway use. The response times for defects requiring urgent treatments may be shorter in a busy urban situation than in a rural situation, although they should be repaired as quickly as resources allow. Response times may also vary according to the location of the defect on the footway. For example, a trip behind a kerb is more of a hazard than a trip next to a wall. It is important that the times set out in the maintenance policy can be achieved in practice.

4.16 Where the defect can be left for a period before treatment, interim treatments are generally carried out to restore the surface of the footway. Interim treatments can be part of a planned maintenance programme. Where the form of deterioration is likely to recur, long-term treatments should be carried out. It may be more cost effective to reconstruct a footway, in accordance with HD 39 (DMRB 7.2.5), than to carry out frequent urgent or interim treatments.

5. TREATMENT TECHNIQUES AND MATERIALS

5.1 If any treatment necessitates temporarily closing the footway, appropriate traffic management procedures must be initiated. Similarly, occupiers of premises with frontages on the footway, should be notified if they will be inconvenienced. It is then important to keep to the planned timetable.

Vegetation Control

5.2 Vegetation control ranges from cleaning moss and lichen off the footway surface to felling trees. Moss and lichen growth on the surface does not cause much damage but can seriously reduce safety by making the surface slippery, especially in wet weather. If trees are growing within or very close to the footway the roots can cause irregularities in the surface. The upward expansion of the roots of forest trees planted in urban areas can cause excessive heave of footways (up to 300mm is not uncommon). Expert advice must be taken before any root pruning, felling or tree replacement is undertaken. The interests of road safety must be balanced against the environmental cost of losing the tree. Further information on the management of trees close to the highway may be found in the Kindreds Association report on highway liability claims (The Kindreds Association, 1994).

5.3 Weed growth is normally the result of poor workmanship during construction or reconstruction, and poor routine management, combined with the proximity of weeds near the footway. An ideal weedkiller would deal with both broad leaf perennials and annual grass-type weeds and would have the following attributes:

(a) systemic - taken in through leaves

(b) translocating - travels through plant to kill root

(c) residual/persistent - active in soil for six to nine months.

5.4 Weedkiller should be applied both to the formation at the construction stage and to the walking surface, the latter being most effective during April to September. The application of weedkiller should form part of the maintenance programme.

5.5 Increasing environmental pressures have led to negligible use of residual herbicides, although there is no formal legislation against their use. Environmentally it is argued that it is desirable to use a contact herbicide, and generically this means the use of Glyphosate based formulations. Effective control of weeds now requires treatment both in Spring and Autumn on the same site, thereby increasing the cost. At formation level the choice of chemicals is broader, but care must be taken to ensure that the product used will not translocate to adjoining properties, hedgerows, fields, parks, etc.

5.6 Extra care needs to be taken in applying weedkiller to non-porous paved surfaces in order to reduce possible contamination of streams and rivers which receive water from paved areas. Spray should be supplied by accurately calibrated equipment using the lowest appropriate rate and avoiding run-off. Products should not be applied over drains or in drainage channels, gullies or similar structures. Personnel applying pesticides must receive appropriate training.

5.7 Full details on all pesticides approved under the Control of Pesticides Regulations is published annually by the Ministry of Agriculture Fisheries and Food and the Health and Safety Executive (MAFF and HSE, 1996). Advice on the safe use of pesticides for non-agricultural purposes is given also in the Health and Safety Commission's Approved Code of Practice (Health and Safety Commission, 1994) and in the Pesticides Users Handbook (Watterson, 1988). Inman (1992) gives useful information regarding weed control in the highway.

Urgent Treatment

5.8 When a defect is identified as a safety hazard it is necessary to carry out urgent treatment to ensure the safety of footway users. As the objective is to remove danger it is not usual to investigate the cause, but rather to undertake a robust repair, as rapidly as possible. Where the defect cannot be treated quickly pedestrians must be warned of its presence.

5.9 **Removal of trips:** Trips in bituminous or concrete footways can be taken out by constructing a temporary ramp of bituminous material. This technique can also be applied to trips around ironwork. In modular footways the module causing the trip should be taken out and relaid. Alternatively the module can be removed and the resulting hole filled with temporary bituminous material.

5.10 **Rocking modules or ironwork:** Rocking modules can be lifted and relaid. If the problem is rocking manhole covers the appropriate statutory undertakers should be informed. If necessary, barriers can be erected until the problem is remedied.

5.11 **Temporary filling of depressions:** Potholes and depressions can be filled with fine bituminous material, (cold mix or asphalt). Prior to placing, all cracked surfacing and loose material should be removed from the area to be repaired. A vertical face should be formed along the edge of the existing material. Any soft or yielding base material should be removed and replaced.

5.12 The base and edges of the area to be filled should be lightly and uniformly tack-coated with bitumen emulsion. When the emulsion has broken (colour change from brown to black) the cold mix or asphalt is placed in layers by hand. (Cut-back or delayed set material may be used for emergency works but durability is poor). It is important to ensure that the surface of the filled depression after compaction is level with the existing footway surface, so the loose level of the infill material needs to be above the surface. The loose thickness of the layer is approximately 1.25 times the compacted thickness.

5.13 Compaction can be carried out using a hand rammer but is best achieved using a vibrating plate. To produce a smooth joint, the edges should be compacted first, with the compactor overlapping the existing surface. A pothole temporarily filled with hand compacted material may be voided with poor durability. It will therefore deteriorate rapidly and patching may be required later to effect a permanent repair.

5.14 **Cleaning of spillage:** A maintaining authority should have an established procedure for this eventuality, based on the COSHH regulations. Spillage should be removed as appropriate, which may require the use of an absorbent medium (such as sand) if the spillage is liquid. All debris should be removed from the surface and disposed of in a controlled and approved manner. The surface should then be washed using an appropriate detergent if necessary. In the event of a chemical spillage the emergency services will advise. Depending on the nature of the spillage it may be necessary to replace the whole or part of the wearing course after the spillage has been dealt with.

5.15 **Barriers:** If a defect presents a safety hazard, and it is not possible to make a temporary repair quickly, it may be necessary to erect some form of barrier. Pedestrian barriers are described in Chapter 8 Paragraph 3.4.4.6 of the Traffic Signs Manual (Department of Transport et al, 1991 or subsequent document). They should be of reasonably solid construction to guide the blind and partially sighted. They should have a robust tapping rail fixed at a height of approximately 150mm above ground level, measured to the underside of the rail, and a robust handrail at a height of between 1.0m and 1.2m, measured to the top of the rail. In both cases the rail should be at least 150mm deep and high.

5.16 **Patching:** Where appropriate, patching should be carried out immediately to remedy hazardous depressions or unevenness in the surface. Patching with bituminous material can also be carried out on modular or concrete surfacing as an emergency repair. Further details on patching may be found in the document Preferred Method 1 Patching (Department of Transport, 1988) and in the Highways Authorities Standard Specification No. 10 (County Surveyors Society, 1995). Patching is discussed in more detail later.

SURFACE TREATMENTS

Bituminous Footways

5.17 Surface treatment has two objectives, firstly, to seal the surface and secondly, to provide a non-slip surface. It also has the advantage of restoring a consistent appearance to the footway. Proprietary products can be painted onto the footway to increase slip resistance in problem areas such as steep slopes. Sealing of a cracked and porous surface can be undertaken using either a surface dressing or slurry surfacing, an extremely cost effective and rapid process. Application of both surface dressing and slurry surfacing is confined to a “seasonal window”. However, with the development of polymer modified slurry seals it is becoming possible to use them throughout the year with the exception of the worst period of winter.

5.18 Whilst patching can be used as a remedy for localised defects it does not prevent deterioration over the whole surface, and leads to the problem of differential deterioration rates and poor overall appearance. Nevertheless, surface repairs to a bituminous footway will usually take the form of patching of one form or another to regulate the surface or remove serious defects, prior to surface treatment work. Patching can be categorised as surface (overlay) or inlaid. Alternative surface treatments are given below.

5.19 **Surface patching or overlay:** Surface patching consists of laying new wearing course material over the existing surface. Since the material should not be feathered out at the edges, this method is only recommended where the existing material can be chased out at the edges and the new material graded to meet the existing surface without causing a trip. It is possible to remove minor irregularities with a surface patch but judgement must be exercised to decide whether a shaping layer is needed first. The process may be described as follows :

(a) Chase out edges of patch.

(b) Brush off any loose material.

(c) Apply emulsion and wait for it to "break".

(d) Paint vertical face with 50 to 100 pen bitumen to effect seal.

(e) Lay wearing course material.

(f) Compact.

5.20 **Inlaid patching:** Inlaid patching is the replacement of defective flexible materials with new material, hand laid, to any depth not less than the wearing course thickness. Each layer of the defective material should be replaced with the relevant material and compacted as specified in HD 39 (DMRB 7.2.5).

5.21 Planing on a footway is becoming much more practicable with the advent of milling attachments for small items of plant, especially rubber tyred skid-steer type. If this type of planer is available, the sequence of operations is as follows:

(a) Plane rectangular areas and step in by 50 - 75mm at the basecourse level if more than a single layer is to be used. (The important consideration here is to ensure that the patch is of sufficient size to allow subsequent rolling. It is pointless trying to carry out basecourse patching if the roller is greater than the width of the wearing course cavity).

(b) Remove any loose materials from the cavity.

(c) Apply bituminous emulsion to the base of the cavity and wait for it to "break".

(d) Paint the vertical edges of the cavity with 50 or 100 pen bitumen.

(e) Fill the cavity with bituminous material.

(f) Compact.

(g) Repeat stages (c) - (f) if wearing course is used in addition to basecourse.

5.22 **Surface dressing:** Surface dressing is a thin veneer suitable for restoring skidding resistance, arresting further fretting and restoring waterproofing properties of the surface. The main limitation of this treatment is that it should only be applied during the warmer months (between April and September). Surface dressing involves the application of a binder to the surface followed by the application of aggregate on to the wet binder. As the binder can be picked up by pedestrians' footwear it is particularly important that occupiers of properties fronting the footway are notified if surface dressing is to be used.

5.23 Care should be used in the selection of sites for footway surface dressing. Since the loading is almost wholly pedestrian there is no post application embedment of the aggregate by vehicles, resulting in a rough surface. Footway surface dressing is most viable for low pedestrian flows and rural areas.

5.24 The surface dressing does not affect any vertical discontinuities in the surface and will leave an uneven surface, if one existed previously. Pre-patching can remove surface irregularities. Surface dressing has the advantage of user colour selection of the chippings, which may be of benefit in some situations. It is recommended that chipping size be kept to less than 6mm with a 3 - 6mm range being preferred.

5.25 Proprietary systems have been developed which use bituminous emulsions and chopped glass fibre strand combined as part of the binder application process. This has the advantage of providing a degree of tensile strength at surface level. The process also has the advantage of "bridging" cracks in a way not possible without the reinforcing glass fibre strand. This has the benefit that less surface patching is needed than with unreinforced systems.

5.26 The process of footway surface dressing is summarised below:

(a) Remove trips and areas of badly degraded wearing course by surface patching.

(b) Apply masking tape to ironwork and street furniture.

(c) Apply binder at determined rate.

(d) Apply chippings at determined rate.

(e) Remove masking tape.

(f) Remove loose chippings within 1 week.

5.27 The design method for surface dressing is given in Road Note 39 (Transport Research Laboratory, 1996); the Road Surface Dressing Association has a Code of Practice (Road Surface Dressing Association, 1995) and a specification for footway dressings is given in the Highway Authorities Standard Specification No. 4 (County Surveyors Society, 1995b). Further information is provided in HD 37 (DMRB 7.5.2.8).

5.28 **Slurry surfacing:** Slurry surfacing is used to stabilise the surface area and to ensure that it is impermeable, of consistent appearance and provides a uniform, slip free, textured walking surface. The process involves the application of a slurry comprising a bitumen emulsion, polymer modifiers, fillers and aggregates blended to control the viscosity and setting time of the mixture as required. The existing footway surface must be cleared of debris, loose material and vegetation by the use of high pressure washing to ensure good adhesion of the slurry.

5.29 Over the last seven years there have been significant developments including the use of polymer modifier technology, which allows for on-site formulation to control the setting time; this means the process is less dependent on the weather. It is also possible to add filler and aggregate to enhance the robustness of the mix. These facilities have significantly increased the capability of slurry surfacings and the period over which they can be applied.

5.30 Some of the more recent formulations contain chopped fibre reinforcement to permit thicker build up of the layers. With the most robust mixes a single layer thickness of up to 40mm is attainable, with multiple layers being used for deeper regulating. It is necessary to allow the first layer to set prior to the application of a subsequent layer; a practical proposition, as setting generally takes no more than 30 minutes. During the setting time it is necessary for pedestrians and vehicles to be kept off the footway, and it is especially important to keep occupiers of properties fronting the footway fully informed.

5.31 The main criterion for the selection of a site for slurry sealing is that it should not be in need of any structural strengthening. A fine, single coat of slurry surfacing can be used if the main problem is confined to surface fretting with no shaping required, while a coarse material with reinforcement can be used to provide up to 40mm of shaping.

5.32 Using modern slurry surfacings it is now possible to treat a footway which previously would have had to be considered for partial reconstruction. Whether a fine or coarse slurry seal should be used is a matter of experienced judgement based on the amount of regulating or damage expected after high pressure washing (if the existing bituminous surface material is brittle). Regardless of the mix the same degree of surface smoothness can be achieved.

5.33 Thin slurry surfacing is more suitable for use on lightly used urban and rural footways. Use of thick slurry surfacing may necessitate the lifting of ironwork. Depending on usage, the life of slurry seal is in the range of five to nine years, with seven years being commonly observed.

5.34 A performance based specification is given in the Highway Authorities Standard Specification No. 3 (County Surveyors Society, 1995c) and further information can be obtained from BS 434 Bitumen Emulsions for Road Use (British Standards Institution, 1984) and HD 37 (DMRB 7.5.2.10).

5.35 **Overlay:** An alternative surface treatment is to overlay the existing wearing course with dense thin wearing course material, ensuring that the degree of compaction is in accordance with that specified in HD 39 (DMRB 7.2.5). When overlaying it may be necessary to chase-out the existing wearing course at the kerb edge and profile the new material to kerb level. This is to avoid a step between overlay and kerb, while maintaining the minimum layer thickness with respect to the aggregate size. Ironwork will need to be raised and care must be taken not to interfere with the efficient use of damp-proof courses and air-ducts on adjacent properties.

5.36 Overlaying with bituminous material can also be carried out on cracked or eroded concrete surfaces, providing the load spreading properties of the deteriorated concrete remain adequate.

5.37 Guidance on the supply and laying of materials can be found in the Highways Authorities Standard Specification No. 10 (County Surveyors Society, 1995a). A list of cold lay surfacing materials currently approved by NJUG (National Joint Utilities Group) can be obtained from NJUG at 30, Millbank, London, SW1P 4RD.

Modular Footways

5.38 Surface repairs to a modular footway are carried out when there are local defects such as trips, depressions and broken or missing modules. Modular footways may also need treatment to repair joints or to restore their slip resistance.

5.39 **Lifting and relaying:** Relaying flags and pavers should be carried out in the same way as laying these modules; according to BS 7263, BS 6717 and BS 6677 for flags, concrete pavers and clay pavers respectively. Guidance on laying setts is given in Annex B of this Part. Useful guidance on reinstating concrete pavers is also produced by Interpave (1999).

5.40 Removing a damaged single module prior to relaying can be difficult, particularly if it is a small element, as breaking it out may disturb adjacent modules. It may be necessary to consider relaying all modules that abut the damaged module, or to relay a full line of modules back to an edge restraint.

5.41 If the surface requires regulating, modules will need to be lifted over the whole of the affected area. In all cases a complete renewal of the bedding material should always take place. It is unusual to need many replacement modules, and this helps to minimise the cost of maintenance. An experienced pavior is required to execute a good reinstatement.

5.42 There is increasing opinion which suggests that modules need to be held apart by some form of strutting when excavation takes place. This prevents a relatively minor inward movement, which would cause problems when replacing those modules that had been taken out. It is also thought that the use of vibratory compaction during the reinstatement of an excavation can be damaging to the remaining modules by increasing their tendency to move inwards to the free edge. This may be avoided if foamed concrete is used for reinstatement of excavations instead of granular backfill.

5.43 If a progressive failure is taking place, it may be necessary to accept the use of a temporary bituminous infill material which will become part of the walking surface, possibly for a considerable time. Although this will provide a safe and comfortable surface for the user, if this treatment increases in area it will become progressively more visually intrusive. An alternative, depending on the size of the failing modules, may be to use a smaller module in the cavity, of a similar colour and texture to the parent surface. This may be feasible where large flags are broken and can be replaced with concrete or brick pavers of size 200mm x 100mm.

5.44 **Joint repairs:** Where a modular bed has been laid with a cement mortar joint, and degradation has occurred, it will be necessary to refill the joint. If necessary the joint should be raked out, which is time consuming and costly. It may be more appropriate to use a small hand-held grinder with an attachment to remove the dust and debris, in a controlled manner, into some form of hopper.

5.45 Once the joints have been cleaned out they can be refilled with a 4:1 sand/cement mixture of normal building consistency. Care is required to confine the mixture to the joint and prevent staining of the surface. Alternatively, a semi-dry mix can be used which is brushed into the joint; the free water chemically activates the cement. The process of hardening takes longer than with a wet mortar but is less likely to stain the surface of the modules. Care should be taken to keep suction sweepers off the surface until the mortar has set and hardened.

5.46 Modular footways with sand filled joints may suffer from loss of jointing sand as a result of suction sweeping or water action. If replacement of the jointing sand is followed by application of a joint sealant it will help prevent future loss of sand. Joint sealant can be used to retain jointing sand; to inhibit weed growth in joints; to reduce porosity, thus enhancing the appearance of pavers by preventing stain penetration; and to inhibit infiltration of water and fuels through paver joints. Three types of sealer are generally available; water based, solvent based acrylic and moisture cure urethane. Emery and Lazar (1996) claim that the urethane sealer is the most effective. Problems can arise with sealant affecting the underlying bituminous layer.

5.47 **Relaying setts and decorative surfaces:** The use of natural stone setts and other decorative surfaces is becoming more common. Any form of repair will generally involve a degree of relaying. On the basis of the increasing numbers of sites showing failure, further research is needed to ascertain the best method of laying setts. Various alternatives are discussed in Annex B of this Part.

5.48 **Retexturing:** Re-texturing of modular surfaces that have become slippery due to heavy pedestrian traffic, can be undertaken by various methods including scabbling, sand or shot blasting, high pressure water jetting or application of a weak acid. Scabbling is slow and tends to crack large concrete flags. It can be used successfully on natural stone flags, especially where there is some form of surface growth. Sand blasting can be successful, but causes a lot of fine particles and debris, which have to be removed separately.

5.49 Shot blasting with steel shot involves the use of specialised machinery, which sucks up the debris and shot by vacuum. The steel shot is separated magnetically in the return loop for continuous re-use. This process tends to form a lightly-exposed aggregate surface on the flags, giving a pleasing appearance. However, regular use of this technique can sometimes cause problems, and retexturing areas around street furniture or at the edges of footways is difficult. Joints may need resealing with sand after any high pressure method has been used.

5.50 **Washing of the surface:** In feature areas it may be necessary to wash the walking surface. This is done by adapted small suction sweepers using hot water with added detergent. In addition to the cleaner appearance there is a significant improvement in the slip resistance.

Concrete Footways

5.51 When a trip has formed this may be regulated using a fine bituminous mix to form a temporary "ramp". Alternatively, if this is unacceptable, it may be possible to reduce the face of the trip using surface grinding equipment. Care should be taken to ensure effective dust suppression, using either water spray or ducted suction. As the process of grinding will render the surface relatively pervious a waterproof sealing coat should subsequently be used.

5.52 Where concrete has become spalled, the damaged area should be removed by scabbling. The surface can be reinstated using a hand-applied epoxy mortar to replace the damaged concrete surfacing. Alternatively, a fine concrete mix can be used if the area needing filling is at least 30mm deep. In this case the edges should be sawn and a bonding agent used to assist adhesion. The new surface should be covered and protected from traffic for at least three days.

5.53 The need for a joint repair at expansion joints will be seen when the joint sealer becomes ineffective, usually by losing adhesion with one side of the joint. In these circumstances it will be necessary to remove and replace the sealer. In the event of spalling of a joint taking place this can best be treated by making a local repair. Further advice on the repair of concrete is given in Section 4 of Volume 7 (DMRB 7.4.2).

5.54 If a section of concrete footway becomes polished due to heavy pedestrian traffic it can be re-textured by shotblasting in a similar manner to that described in the repair of footways comprising modular construction.

STRUCTURAL REPAIRS

5.55 Where defects are due to failure at greater depth than the wearing course alone, deeper repairs will need to be carried out. This may involve replacing all bituminous material, concrete or modular paving and, possibly, the sub-base.

Bituminous Footways

5.56 **Basecourse replacement:** When replacing the wearing course alone is judged inadequate (eg. due to the need to replace more than 40 per cent of the basecourse at the same time) it becomes more cost effective to consider a complete replacement of all the bituminous layers. The existing wearing course and basecourse material is removed by planing or digging out, the granular base is rolled and restored to line and level, and each layer is replaced with the relevant material as specified in HD 39 (DMRB 7.2.5). The process brings the footway up to its original structural condition.

5.57 If required, the wearing course and basecourse may be combined as one layer when replaced; this will provide a longer working time in cold weather, but compaction will require more effort due to the greater thickness. The main benefit is that there is also a better chance of achieving a higher degree of compaction which results in a potentially longer service life. The cost of this is less than the conventional two-course construction since there is a lower labour cost due to a single layer being laid.

5.58 **Recycling:** This may be considered when investigation indicates that the construction and condition of the existing footway materials are suitable. The primary factors are that the footway exhibits cracking and general degradation and is not suitable for slurry surfacing. If the footway has had slurry surfacing applied twice previously, a third application is not recommended, but recycling will rejuvenate the remaining bituminous material.

5.59 Cold mix-in-situ techniques are used to re-use the existing bituminous materials, which are then surfaced with a new wearing course or slurry surfacing. The footway is restored to near its original condition. Where the footway is not subjected to overrun this may be a cost effective treatment having a similar life expectancy to reconstruction. The economics will vary considerably depending on the area to be treated. The process is also considerably more environmentally friendly than reconstruction as it makes use of the existing material rather than disposing of it.

5.60 The use of this process ("Retread") is becoming much more common with the introduction of small scarifying plant. The process consists of scarifying both the wearing course and basecourse to a depth of up to 75mm, followed by grading for level and crossfall. Bitumen emulsion is then introduced into the body of the material with specialised pressure harrows. Depending on circumstances, it may be necessary to add further crushed stone to "fill-out" the scarified mass, this being a matter of experienced judgement. It is also necessary to remove a certain amount of material to permit the placing of a new wearing course.

Modular Footways

5.61 An in-depth repair of a modular surface comprises the lifting and relaying of the existing modules followed by replacement and re-levelling of the laying course. Partial replacement or re-levelling of the sub-base may be required to remove depressions or bumps. The major advantage of modular construction is the probability that few new modules will be required. This process will not enhance the structural capability of the footway and a careful evaluation will be required to ensure that it is not necessary to reconstruct the base to strengthen the footway. (Refer to Chapter 4 of this Part).

5.62 Relaying of modular footways may be regarded as environmentally friendly as it results in substantial recycling of in situ materials. Even if the materials are not to be used on the site in question they may be used elsewhere.

Concrete Footways

5.63 An in-depth repair of a concrete footway will inevitably lead to the replacement of a concrete slab or slabs. After breaking out the existing slab(s) the process of laying the new slabs is described in Annex C of this Part.

In-situ Stabilisation

5.64 Where it is possible to treat a poor subgrade and/or unbound granular layer by stabilising it, rather than excavating and replacing it, this course of action should be considered if it is economically justified. Cement and lime are the stabilising agents most frequently used. The process consists of scarifying to the depth of the layer to be stabilised, reshaping as required to correct the profile, lightly compacting, spreading and mixing in the stabilising agent and water, compacting and trimming.

5.65 Stabilised patches normally require dampening and a curing coat to ensure that enough water is available for the chemical reactions necessary for stabilisation to proceed. A typical curing coat would consist of a light application of either cut-back bitumen or bitumen emulsion, with a sand or light aggregate cover.

Reconstruction

5.66 Due to the range of repair and enhancement techniques available the need for reconstruction is generally only required when it is necessary to upgrade the structural capability of the footway to deal with the effects of vehicular damage. This will inevitably require a thicker construction and design recommendations are given in HD 39 (DMRB 7.2.5). Since reconstruction involves a considerable investment it is appropriate to carefully consider alternative constructions and their whole life costs.

KERBS

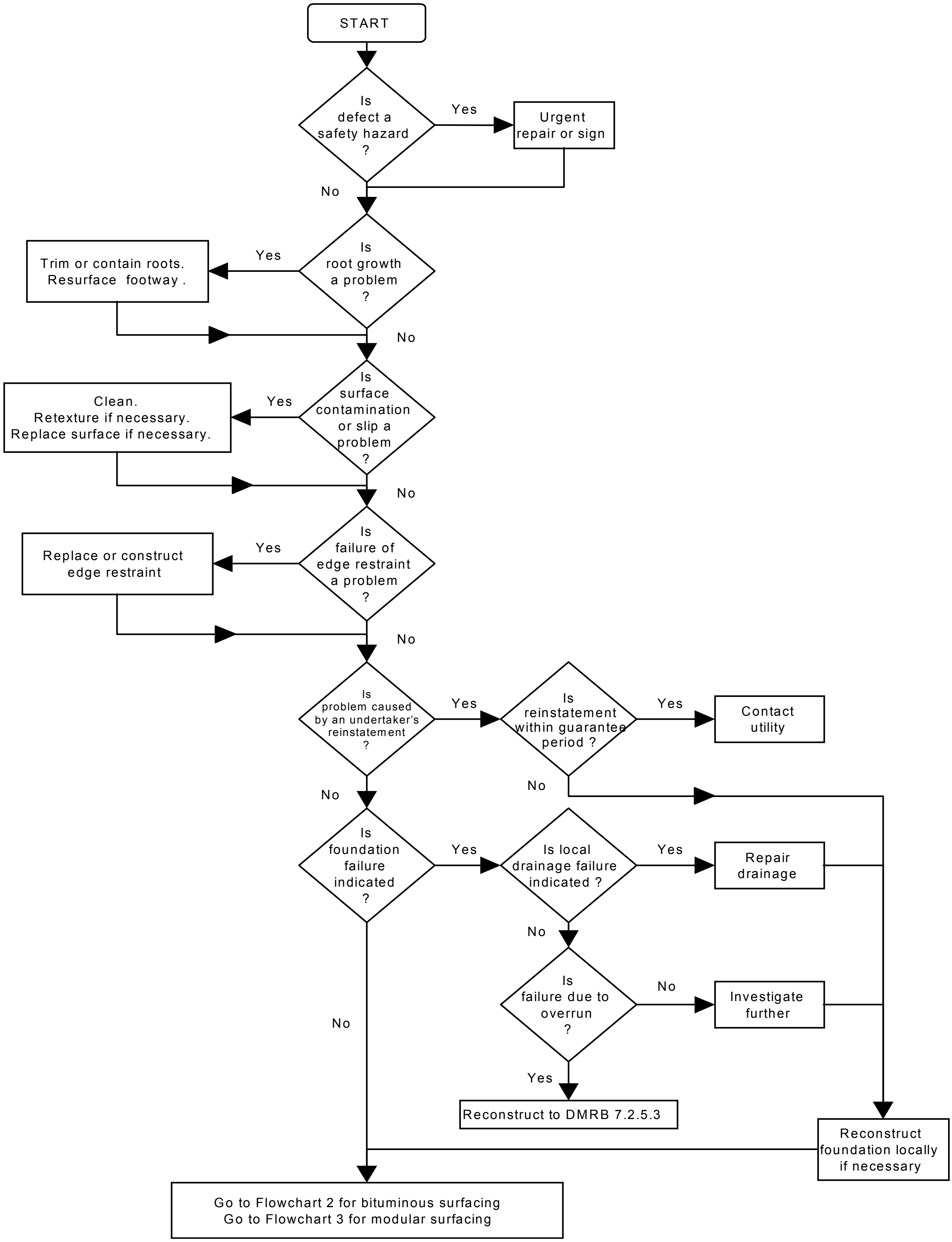
5.67 Replacement of kerbs almost always involves disturbance of the carriageway surface. It may be necessary to remove more kerbs than those immediately affected to get a good alignment. Where kerbs and edges have sunk as a result of an excavation, it may be necessary to provide a regulating patch on the channel or footway. Care should be taken to ensure a waterproof joint is achieved between the kerb and the carriageway to prevent ingress of water to the sub-base. The joint between the kerb and carriageway wearing course should be painted with a 50 pen bitumen before laying the wearing course.

5.68 The need to replace a kerb should normally be judged against the danger it causes to pedestrians. In some maintaining authorities, however, a spalled kerb may be replaced for environmental reasons although it may not be causing a safety problem.

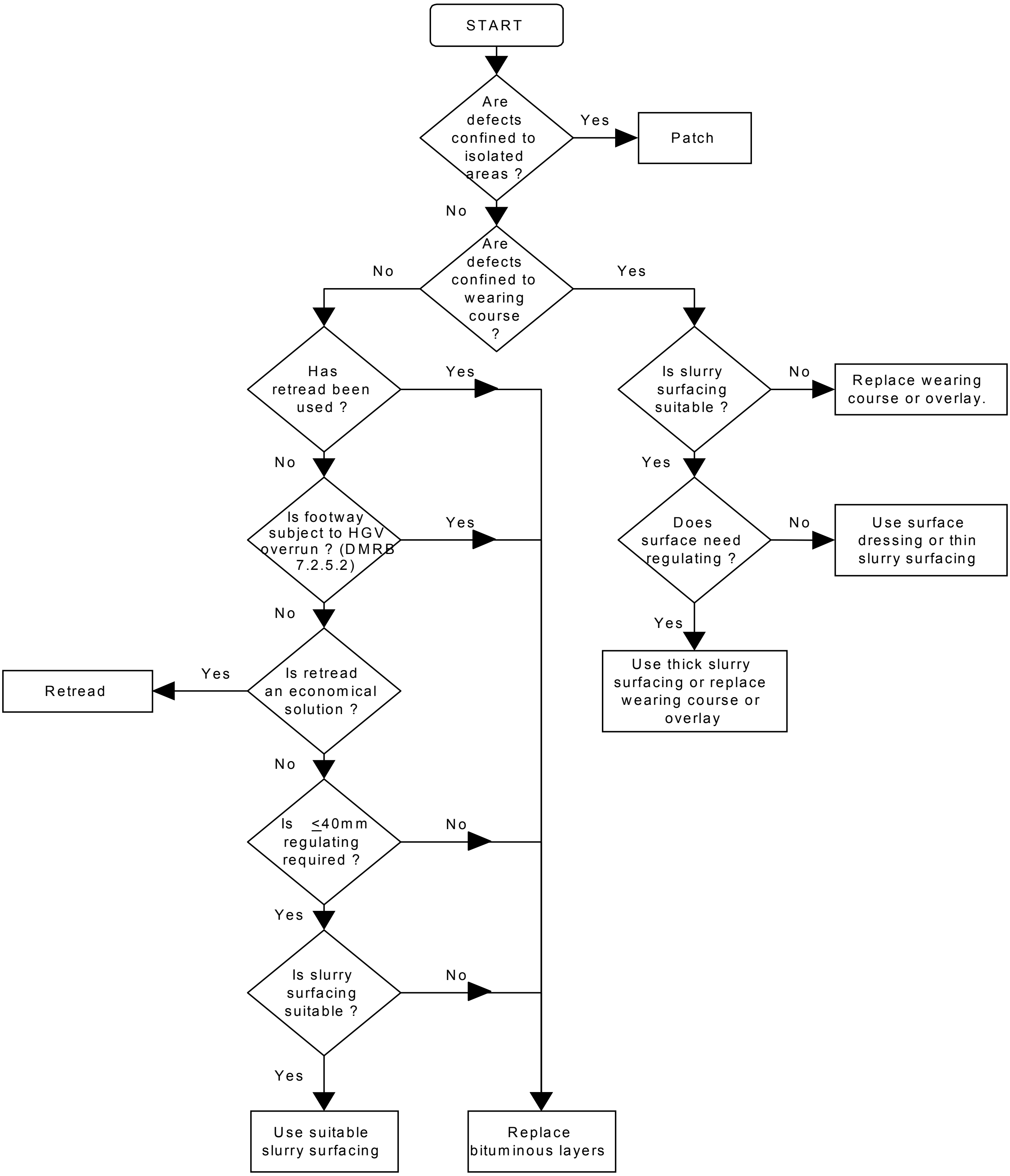
5.69 The repair or replacement involves the removal of the existing kerb, regulating the bed with semi-dry concrete, (Grade C7.5P) and the relaying of the kerb or edging, prior to reinstating the adjacent surfaces of the carriageway and footway in materials identical to the existing ones, if available.

TYPICAL FLOWCHARTS

5.70 A series of flowcharts is presented below to assist the choice of appropriate maintenance. Flowchart 1 is applicable to all types of footways and leads into Flowcharts 2 and 3, which apply to bituminous and modular surfacings respectively. There is no flowchart for concrete surfacing as such footways are not common.



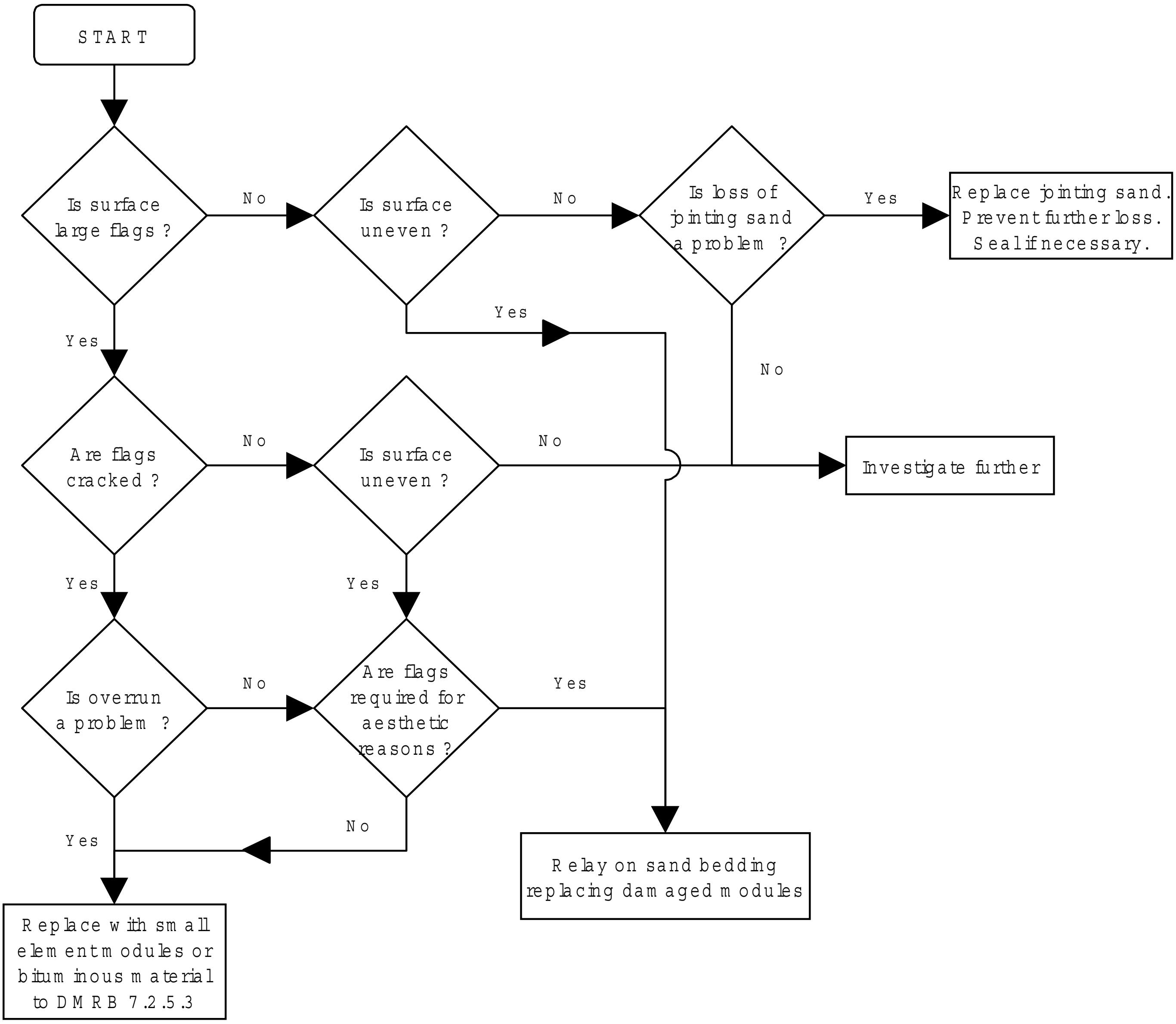
FLOWCHART 1 : GENERAL



FLOWCHART 2 : BITUMINOUS

Notes If slurry surfacing has already been used twice for maintaining the surface, it is probable that the bituminous surface needs replacing rather than another application of slurry surfacing.

Any overlay, including thick slurry surfacing, can only be used if levels of damp proof courses etc allow.



FLOWCHART 3 : MODULAR SURFACING

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7. ENQUIRIES

All technical enquiries or comments on this Standard should be sent in writing as appropriate to:

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ANNEX A DESCRIPTION OF DEFECTS

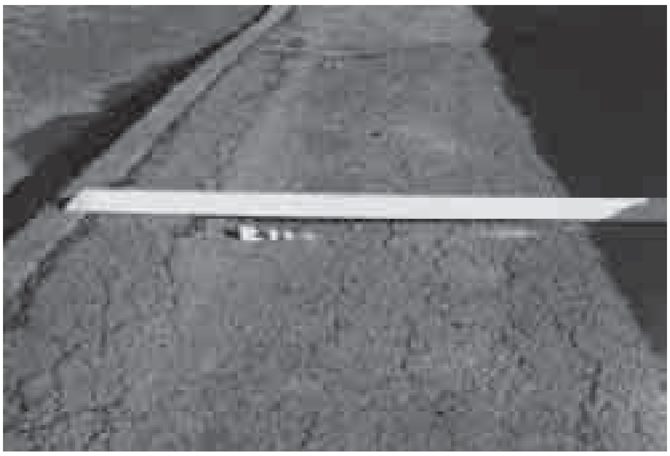
A.1 DEFECTS COMMON TO ALL TYPES OF FOOTWAY CONSTRUCTION

Depressions and bumps:

Circular or oval shaped depressions are usually a sign of local failure at sub-base or subgrade level. The causes are many and varied and should be investigated if the problem is more than an occasional depression. Local depressions can occur where vehicles park or overrun the footway, especially where the foundation is weaker than surrounding areas, possibly as a result of a drainage problem. Long narrow depressions are usually a sign of settlement in an undertaker's trench and are often accompanied by cracks and steps along the edges of the depressions.

Bumps may be due to root growth or heave of the foundation. Heave may result from the ground swelling due to tree removal or the formation of ice lenses in winter due to insufficient protection to a frost susceptible soil. Due to the varying nature of the soil and moisture condition, the heave will be uneven, resulting in bumps. Surface irregularities can also result from faulty construction or drainage faults.

Rutting:



Longitudinal rutting usually occurs close to the kerb, caused by vehicles parking on the footway to avoid causing an obstruction in the road. Transverse rutting may occur at vehicular accesses. Although longitudinal ruts are more frequent and often deeper than transverse ruts, the latter are noticed more by pedestrians who may trip over them. In flag footways rutting is generally associated with cracked flags. It is important to identify whether the rutting is structural (due to failure of the foundation as for 'depressions') or non-structural (confined to surface layers only, exacerbated by long loading times of parked vehicles, and both high temperatures and high penetration binders in bituminous materials).

Slippery surface:

The majority of materials used for footway surfacing have a satisfactory inherent slip resistance. However, slip resistance can be affected by polishing of the surface due to constant trafficking, use of inappropriate aggregate, or growth of moss or lichen. Slurry surfacings, in particular, may become polished with age and wear.

Surface contamination:

Surface contamination by foreign substances affects the aesthetic appearance of a footway by staining or discoloration. Fuel spillage may seriously lower the skid resistance, or soften bituminous material. It requires rapid removal, or the application of a neutralising agent, if damage is to be avoided.

Vegetation:

Vegetation is remarkably persistent and will grow in any crack or gap which becomes filled with debris. Vegetation will therefore tend to be less of a problem in those footways which are cleaned and maintained regularly. Tree roots cause heave of the footway with associated cracks and trips. Weed growth in cracks and gaps causes them to widen leading to unevenness. Moss and lichen may make the surface slippery when wet.

Water:

Water emerging from the footway is a nuisance to pedestrians and will lead to rapid deterioration of the footway if left untreated. It could be caused by a spring or, in urban areas, it is probably due to a leaking water main or a blocked drain. During freeze/thaw cycles the water may cause safety hazards. Standing water may occur in depressions, due to deterioration or to insufficient gradient on the surface profile, and may become a hazard to pedestrians in freezing conditions.

Cracks or joints in the footway surface may allow the ingress of water which will subsequently weaken the structure. Freezing water in cracks will cause further damage.

A.2 DEFECTS: BITUMINOUS FOOTWAYS

Excess binder:

This may be due to high temperatures or to binder rich material having been used. It requires treatment because of the inconvenience to pedestrians.

Mosaic cracking:

This may be due to structural failure of the foundation or embrittlement of the bituminous material. (Bitumen hardens in the presence of air and sunlight, and can lead to material which becomes brittle). Mosaic cracking appears as an area of approximately hexagonal plates with the dimension of the plates of the order of 50 to 100mm; the thicker the bituminous construction the larger the plate.

Linear cracking:

Cracking can vary from occasional hairline cracks, only visible in a drying surface, to major problems with gaps over 15mm and a difference in level across the crack of a similar dimension. The cause of the cracking needs to be established in order that appropriate maintenance be carried out. Linear cracking can occur due to ground heave or to differential settlement alongside a reinstatement. It may be reflective cracking, occurring if a bituminous surfacing is placed on a stabilised base, where cracks can be initiated by thermally induced stresses and by vertical movements between adjacent cementitious slabs caused by loading.

Loss of surface aggregate:

This can be due to fretting, stripping or loss of binder due to local pollution. Superficial **fretting** appears as a 'dryness' of the surface and a slight dustiness which arises as fine particles of aggregate in the surface loosen from the bitumen. This usually occurs in winter when the bitumen is more brittle. If it remains untreated it is likely to lead to loss of coarse aggregate on the surface and to ingress of water. Loose surface material can become a safety hazard. When aggregate is lost from slurry surfacing it can result in a smooth and, sometimes, slippery surface.

Stripping occurs when the binder has poor affinity to the aggregate. Water penetrates between the bitumen and the aggregate causing the aggregate to be stripped of binder. This occurs most frequently at the bottom of the wearing course layer when it has a high void content. Once the surface is broken, failure can progress rapidly, as the loose material at the bottom of the layer is no longer contained.

Delamination may be a common problem with thin slurry surfacing. The thin layer peels off due to lack of adhesion with the underlying material. This can occur because of poor workmanship or when the thin surfacing becomes worn through.

Potholes:

If fretting or stripping are allowed to continue unabated then it is likely that potholes will develop due to loss of material. This is the most obvious sign of failure of the upper layers of the footway and can be dangerous. The depth of a pothole usually equates to one or more complete bituminous layers.

A.3 DEFECTS: MODULAR FOOTWAYS

Broken or damaged modules:

Cracking can be merely unsightly or can be a hazard where it leads to wide gaps or trips. It can occur due to a combination of thermal warping and/or traffic loading. Thermal warping will lessen the support under the flag and traffic loading may then produce stresses higher than the modulus of rupture of the flag. The larger and thinner the flag, the larger the warping and traffic induced stresses. Cracking can also be a result of fatigue due to repeated loading. A stabilised bed provides no support to a warped flag and is thus unsuitable.

Loss of jointing material:

Loss of jointing material can be caused by trafficking, weather, water ingress, vegetation growth or the suction action of mechanical sweepers. For rigid jointing material the defect mechanisms leading to loss are the same as those of concrete. Mechanical breakdown or loss of jointing material causes modules to lose any interlock, thus reducing the load spreading ability of the modular surfacing. Modules also become free to move laterally and to rotate, which may result in rocking modules or widening of joints.

Missing modules:

Missing modules leave holes and trips, allow water to accumulate and weaken the structure of the remaining modules.

Rocking modules:

A paver, flag or sett which is not supported evenly will rock when loaded. The problem is exacerbated if the rocking pumps water and fines out from under the module, reducing the support further. This fault is usually only detectable if the module is walked on.

Spalling of arrises or surfaces:

Spalling of arrises can occur when modules rotate due to loading during construction or use, or lack of support, especially if the joint gap is small. Spalling occurs as adjacent modules exert pressure upon each other. Chips may be knocked off the top corners of flags or pavers when laying or during the life of the footway. This can detract from the visual appearance but rarely becomes a hazard.

Spalling of the surface, or loss of surface material, may occur if inappropriate natural materials are used and is unsightly rather than hazardous. It may be due to a manufacturing defect, impact loading, abrasion, weathering or possible chemical attack. York stone suffers from delamination which may result in an uneven surface.

Trips:

Trips are caused where modules settle unevenly or crack. Where the difference in level is marked, trips present a hazard to pedestrians. This is more likely to be a problem with large flags.

Unzipping:

Loss of interlock and movement of blocks or pavers may occur due to disturbance by excavation or to poor initial construction.

Widening of joints:

This may be indicative of ground movement, loss of jointing material or failure of footway edge constraint.

A.4 DEFECTS: CONCRETE FOOTWAYS

Defects which occur in concrete flags or blocks, such as spalling and cracking, may also occur in mass concrete footways. Other defects are:

Cracking:

If large areas of concrete are laid without joints the concrete will crack as it cures. Cracks may also occur due to the concrete having insufficient tensile strength to support the stresses caused by loading and temperature changes. If the concrete has cracked sufficiently to impair its load spreading ability, depressions or ruts may result.

Damaged joints:

Damaged joints may occur as a result of movement of the concrete slabs due to loading or expansion. Spalling and cracking can result.

Surface damage:

The surface appearance can change and deteriorate due to weathering (sun, temperature changes, rain, snow, atmospheric pollution, freeze/thaw) which can result in cracks, and sometimes weed growth. Disruption caused by expansion of water on freezing can cause shallow surface scaling and delamination, leaving a rough surface. The effect is more pronounced for concretes with lower cement contents, because these have less strength and are more porous (interconnecting voids). However, air entrained concrete has excellent resistance to frost attack, since the discrete voids created by the admixture allow room for freezing water to expand without spalling the concrete. Chemical attack can lead to the surface aggregate becoming exposed or large areas of surface concrete being destroyed. Zones more prone to attack are near gullies where there may be a plentiful supply of contaminated water.

Poor constituents:

In normal concrete, strength development is derived from chemical reactions between water and cement. If bagged cement is stored under damp conditions it will chemically react and become solid. These reactions are not reversible. Hence the content of the bag should not be used because the product will have low strength and very poor durability. Contaminated aggregates are also a common cause for severe deterioration of concrete, particularly those contaminated with sulphate. If contaminated aggregates are used the concrete will show significant deterioration after winter weathering. As wood or other forms of contamination decompose, cracks will appear, caused by the ingress of water followed by freeze/thaw cycles.

A.5 DEFECTS: KERBS AND EDGING

Many of the defects which may be noted during an inspection of kerbs and edgings are common to modular surfacing, such as trips, loose or rocking kerbs or damaged kerbs. Vehicles colliding with kerbs are a common cause of defects. Apart from immediate repairs undertaken for safety reasons, defective kerbs should be replaced in an annual programme, generally in association with other carriageway or footway defects.

Broken or missing items: This may result in a loss of edge support to the footway. York stone kerbs may suffer from delamination

Horizontal or vertical steps:

If the kerb projects into the carriageway it may be dangerous for road users. Vertical steps may be a hazard for pedestrians.

Poor alignment:

If preformed channels are part of the kerb, poor alignment can lead to drainage problems and water collecting in puddles. Poor kerb alignment may be a symptom of overrun, and may lead to ingress of water.

Spalling of arrises or faces:

Chips may be knocked off the top corners during the life of the footway. This can become a hazard depending on the extent of the damage. Spalling of the surface, or loss of surface material, may occur if inappropriate natural materials are used, and may become hazardous if vehicles mount or “knock” the kerb.

Vegetation growth:

Growth of vegetation along the edge of a footway or in drainage channels may prevent over edge run-off of water causing inconvenience to footway users.

ANNEX B LAYING NATURAL STONE SETTS AND DECORATIVE SURFACES

The traditional Victorian method of laying setts involved setting them to about mid depth in a dry crushed stone of 6mm nominal size. The top half of the joint was then filled with a poured bitumen, care being taken not to stain the surface. This process has the benefit of robustness, impermeability and long lasting joints. The joints can easily be repaired using poured bitumen if degradation takes place.

An alternative method is to fill the top half of the joints with a crushed granite of 0 - 6mm grading. Following the initial tamping, usage of the footway progressively causes the aggregate to “lock up” and become impermeable.

Present day practice is to use a stabilised sand at 6:1 or 8:1 sand/cement for the bedding, and fill the top half of the joint with a semi-dry mix of 3:1 or 4:1 sand/cement. Initially, this provides an impervious and frost resistant joint. However, thermal stresses will inevitably cause cracking leading to eventual degradation of the joint and reduced service life; hence this method cannot be recommended.

Widely used in Europe, but much less so in the UK, is the practice of bedding and filling the joints with a 2 - 5mm crushed stone, used dry when laid, and watered on completion. The process of watering assists filling of the joint. The crushed stone “tightens up” in the joint with time and successive load applications, and it also facilitates very easy relaying as the jointing material and setts can generally be re-used. It must be emphasised that there is a considerable degree of laying skill required. Judgement must be exercised about which sett will be a better fit, against those already laid, because each one has a unique shape.

The laying course is 50mm thicker than the characteristic half depth of the setts. On selection of a sett, the mason forms a cavity in the laying course with a snipe nosed hammer, places the sett and settles it into place with the hoof of the hammer. Final settlement may be done using a hand rammer as a separate process. If a straight joint is being used, each line is laid to a string line. In the event of more decorative designs being used, for example the fan pattern, the setting out is somewhat more complex and requires skilled judgement to ensure the pattern is achieved.

A development of these two methods is to lay the module in a semi-dry sharp sand/cement mix (4:1 or 3:1) and for the top half to be filled with a liquid mortar. The appropriate mix for this is 1 part sharp sand, 4 parts building sand, 2 parts ordinary Portland cement. The mix should be to the consistency of “custard” and it should be poured into the joint to ensure complete filling. There is the need to spend time wiping the surface clean to prevent staining. This method of laying is also appropriate where local decorative feature panels have been included in the footway surface.

Further advice will be available in the SCOTS “Good Practice Guide for the Use of Natural Stone Surfacings for Roads and Paths” to be published in 2000.

ANNEX C LAYING CONCRETE SLABS

A typical concrete slab footway consists of 100mm thickness of 40 N/mm^2 concrete laid in maximum lengths of 3m on a waterproof surface membrane on an appropriate base.

Prior to placing the concrete, a waterproof membrane consisting of either waxed building paper or 500g polythene sheet should be placed. This prevents suction of the moisture in the wet concrete into the granular sub-base.

Concrete of medium workability, maximum 50mm slump, is laid in alternate bays with construction joints between each bay and expansion joints every third bay. The concrete should be tamped before being floated and finally finished with a lightly-drawn transverse broom.

Details of the expansion joint is similar to Drawing number C2 in Highway Construction Details (MCHW3) except the dowel bar is not used. The construction joints are formed against a stop end board which is removed prior to laying the adjacent slab.

ANNEX D WORKED EXAMPLES

EXAMPLE 1

A narrow bituminous footway is adjacent to a relatively narrow carriageway which is on a bus route in a residential estate. The damage has occurred over the last 5 years, since the introduction of the bus route. The footway suffers overrun by buses as well as private cars and light delivery vehicles. The kerbs are less than 75mm in height and the back of the footway is poorly supported.

Flowchart 1:

Is urgent treatment required? ***Chapter 2, Clause 2.3***

Although the footway is in a generally bad state of repair it does not present an immediate safety hazard.

Investigate cause of defect(s). ***Chapter 3, Annex A***

Following Flowchart 1, root growth and surface contamination or slip are not a problem, but there is some failure of the edge restraint as the kerb is low and the back edge of the footway is not well supported. Defects are not due to reinstatement failure, but foundation failure is indicated as there is rutting behind the kerb.

Maintenance Option:

The footway should therefore be reconstructed according to DMRB 7.2.5.3 (Heavy-vehicle design). Consideration should be given to lifting the kerbs to help prevent future overrun. Replacement of the surfacing will also be required.

EXAMPLE 2

A bituminous footway is situated in a cul-de-sac in a residential area approximately 30 years old, and has received little past maintenance. It suffers overrun by private cars and delivery vehicles. The bituminous material shows signs of a combination of thermal and age induced cracking. There is a longitudinal rut, over 25mm deep, on the footway.

Flowchart 1:

Is urgent treatment required?

Although the footway is in a bad state of repair there is no immediate safety hazard.

Investigate cause of defect(s).

Following Flowchart 1, there is no root growth, surface contamination or slip, failure of edge restraint or failure of reinstatement. The longitudinal rut indicates foundation failure due to overrun (Chapter 3, Clause 3.23).

Further considerations:

As the footway has received little maintenance over 30 years, and the deformation appears to have been progressive during that time, it is worth considering removing the deformation by replacing only the bituminous layers. However if the foundation is not sufficiently strong, the problem may recur (Chapter 4, Table 4.2).

Maintenance Options:

Use of a thicker bituminous layer would strengthen the footway construction. The footway may need to be reconstructed according to DMRB 7.2.5.3 (Light-vehicle design).

EXAMPLE 3

A bituminous footway in a residential area presents an uneven surface due to considerable loss of wearing course material. Some of the kerbs are slightly out of line due to undertakers' activities. There is no rutting.

Flowchart 1:

Is urgent treatment required?

There is no immediate safety hazard.

Investigate cause of defect(s).

Following Flowchart 1, there is no root growth, surface contamination or slip, failure of edge restraint, reinstatement or foundation.

Flowchart 2:

Assess extent of defect(s).

Defects are not confined to isolated areas but, apart from the detail of kerb alignment, are confined to the wearing course.

Maintenance options:

The use of a thick slurry surfacing, to seal and regulate the surface, is indicated. This will need to be keyed in at the back of the kerb (Table 4.2 and Chapter 5, Clauses 5.28-5.34).

As the carriageway also appears in need of attention, the footway and carriageway works could be carried out at the same time and the kerbs could be realigned. As the kerbs are only slightly out of alignment they would not be realigned unless carriageway works were being undertaken.

EXAMPLE 4

A bituminous footway in a late 1950's residential estate is in need of maintenance. The general view of the estate shows depression of kerbs due to a vehicular crossing and cracking in an old undertakers' reinstatement. The photograph of the corner shows that the kerb in the centre has been replaced in the past and it appears that the final patching at the back and front was not completed. The replacement kerb is shorter than the original and the kerb adjacent to the gully is tilting. In the upper part of the picture, overlaid patching following undertakers' activities has failed leaving a trip. There is no rutting.

Flowchart 1:

Is urgent treatment required?

If the trip height presents a safety hazard a temporary ramp of bituminous material should be placed until a permanent repair can be carried out (Chapter 5, Clause 5.9).

Investigate cause of defect(s).

Following Flowchart 1, there is no root growth, surface contamination or slip, but there is failure of edge restraint and the tilting and unsuitable kerbs should be replaced (Chapter 5, Clauses 5.67 - 5.69). The failed reinstatement is well over 2 years old and is not, therefore, in the guarantee period. There is no indication of foundation failure.

Flowchart 2:

Assess extent of defect(s).

Defects appear to be confined to the wearing course. The worst defects are in isolated areas.

Maintenance Options:

Defects could be treated with more overlay patching (Chapter 5, Clauses 5.19 - 5.21, 5.35 - 5.37). However, the appearance of the footway would be enhanced if it were resurfaced rather than receiving further patching.

The use of a slurry surfacing would give the footway an homogenous appearance and could be beneficially used as preventative maintenance on the remainder of the footways in the estate. A thick slurry surfacing will need to be keyed in at the back of the kerb (Chapter 5, Clauses 5.28 - 5.34).

EXAMPLE 5

The photographs show the footway on both sides of the road in an urban residential area with terraced houses. It appears to have been originally surfaced in stone flags which have been replaced with bituminous construction. The stone kerb is believed to be original. The kerb has been displaced because of growth of tree roots which have also caused cracking of the bituminous surface.

Flowchart 1:

Is urgent treatment required?

The displaced kerb is a safety hazard and should be removed until it can be replaced (Chapter 5, Clauses 5.8 - 5.16).

Investigate cause of defect(s).

Following Flowchart 1, root growth and subsequent failure of edge restraint and cracking are the only problems.

Further considerations:

Trees in residential areas, while undoubtedly environmentally attractive, cause many ongoing maintenance problems, some of which are illustrated here. A permanent reconciliation of the maintenance problems is not possible without removal of the trees. Experience indicates that this is unlikely to be possible. Maintenance is therefore likely to be ongoing to keep the footway and channel safe.

Maintenance Options:

The tree roots should be pruned, if possible, to minimise future problems. The displaced kerb can be shortened to fit around the roots and narrower edging can be used immediately adjacent to the tree. The concrete edging forming a box around the tree can be replaced leaving more room for root growth, providing that the footway remains sufficiently wide for pedestrians. The bituminous footway needs relaying where it has become uneven (Table 4.1 and Chapter 5, Clauses 5.55 - 5.60).

EXAMPLE 6

A footway in a residential street some 40 years old has not received any maintenance since its construction. The surfacing is worn and uneven with some loose material, significant loss of wearing course material, cracking and weed growth. Missing kerbs have been patched with bituminous material.

Flowchart 1:

Is urgent treatment required?

There are no specific safety hazards but loose material and unevenness make walking on this footway difficult. The priority given to maintenance will depend on its location.

Investigate cause of defect(s).

Following Flowchart 1, the surface should be replaced and the edge restraint reconstructed. Foundation failure is not indicated.

Flowchart 2:

The deterioration is general, not confined to isolated areas or to the wearing course. The footway is too degraded for slurry surfacing to be used. The footway is not subject to HGV overrun and retread has not previously been used, so it is one possibility.

Maintenance Options:

The kerbs and the bituminous layers need replacing (Table 4.5 and Chapter 5, Clauses 5.56 - 5.60). Retread could be an option, depending on the economics of the situation.

Further considerations:

If the level of undertakers' works is very high then the minimum cost treatment should be used.

If the whole area is likely to be part of an improvement scheme a change in surfacing, to modular, could be considered.

EXAMPLE 7

A footway in a small market town suffers from overrun, especially from heavy delivery vehicles, which has caused the kerbs to sink. This has allowed the formation of a trip adjacent to an undertaker's cover.

Flowchart 1:

Is urgent treatment required?

The trip does not appear to constitute an immediate safety hazard, but could be taken out, temporarily, by ramping with bituminous material if necessary (Chapter 5, Clauses 5.8 - 5.16).

Investigate cause of defect(s).

Following Flowchart 1, the kerb should be replaced. Foundation failure is indicated as the kerb has sunk and rotated and the footway behind the kerb is depressed.

Flowchart 2:

The deterioration is confined to an isolated area and patching is therefore indicated.

Maintenance Options:

The footway should be strengthened locally to prevent further deterioration due to overrun. When the kerb is being realigned the sub-base under the corner of the footway could be replaced with concrete to give additional strength (Chapter 5, Clauses 5.67 - 5.69). This could be brought to the surface level or an inlaid patch of bituminous material could be applied over the concrete (Chapter 5, Clauses 5.20 - 5.21).

Further considerations:

If the cover to the undertaker's apparatus is not suitable for an overrun situation the appropriate undertaker should be informed and the cover replaced.

EXAMPLE 8

A flagged footway on a 100 year old urban street is in a bad state of repair. The footway is surfaced with large natural stone flags. Most kerbside flags are cracked and the kerbs have sunk. A combination of overrun by delivery vehicles and laying of undertaker’s apparatus, with inadequate backfill to the trench before the flags were relaid, has caused breaking and spalling of the flags.

Flowchart 1:

Is urgent treatment required?

Safety hazards such as significant trips or rocking flags need to be dealt with as a matter of urgency. Modules can be replaced, temporarily, with bituminous material (Table 4.3 and Chapter 5, Clause 5.9).

Investigate cause of defect(s).

The edge restraint has failed and the kerb should be replaced (Table 4.5 and Chapter 5, Clauses 5.67 - 5.69). It is unlikely that reinstatement failure is the only cause of the cracked flags, because of the known problem of overrun. Foundation failure is indicated as the kerb has sunk and flags next to the kerb are cracked, with some rutting.

Maintenance Options:

The footway should be reconstructed following the recommendations of DMRB 7.2.5.3 (Heavy-vehicle design).

Further considerations:

Consideration needs to be given to the choice of surfacing materials. The footway could be surfaced with bituminous material or small element modules. If natural stone flags are required for environmental reasons then overrun should be prevented. This could be achieved by the installation of bollards (Refer also to Chapter 5, Clause 5.47)

When the kerbs are relaid the roadside face will be higher than at present. The actual height selected will depend upon the threshold levels of the adjacent building, and the need to maintain falls towards the carriageway.

EXAMPLE 9

A flagged footway is adjacent to a public house. Damage has been caused by delivery vehicles, more particularly due to the impact loading caused by the off-loading of barrels.

Flowchart 1:

Is urgent treatment required?

Although many flags are broken there are no significant trips, but heels may catch in the open joints.

Investigate cause of defect(s).

Defects are not due to root growth, surface contamination, failure of edge restraint, reinstatement or foundation.

Flowchart 3:

Flowchart 3 indicates that, as overrun is a problem, the footway should be resurfaced with small element modules or bituminous material (Table 4.3). However, as the surface is subject to severe impact loading the surfacing will need to be capable of resisting this.

Maintenance Options:

One option would be to resurface the footway with 80mm thick concrete blocks (Chapter 5, Clauses 5.38 - 5.43). An alternative would be to use pavement quality concrete with the addition of polypropylene fibres, or, alternatively mastic asphalt could be used (Refer DMRB 7.2.5.4).

EXAMPLE 10

A flagged footway in a suburban street requires attention because of trips around mature trees. The footway is otherwise in a good state of repair.

Flowchart 1:

Is urgent treatment required?

There are some significant trips which should be removed as soon as possible (Table 4.3 and Chapter 5, Clause 5.9).

Investigate cause of defect(s).

Defects are due to root growth making the flags uneven, creating large trips because of the size of the flags.

Flowchart 3:

Flowchart 3 suggests that the large flags should be replaced with bituminous material or small element modules.

Maintenance Options:

In this situation the use of block paving could be appropriate (Chapter 5, Clauses 5.38 - 5.43). The small modules would minimise both the trips caused by future root growth and the area to be relaid on each occasion when future maintenance is necessary. Bituminous material is also an appropriate surfacing and would minimise the trips (Refer DMRB 7.2.5.4).

EXAMPLE 11

A footway in a shopping centre is surfaced in concrete blocks. It has a depression along the line of an undertaker's reinstatement that was carried out three years ago.

Flowchart 1:

Is urgent treatment required?

No safety hazards reported so maintenance can be part of planned programme.

Investigate cause of defect(s).

Defects are due to reinstatement failure, but three years is outside the HAUC guarantee period. However, the engineer should consider which undertaker is responsible and enlist their co-operation to investigate the problem (Table 4.1).

Foundation failure along the reinstatement is indicated. This may be due to faulty construction or to drainage problems such as water tracking along utility pipes.

Flowchart 3:

As far as the surfacing is concerned, loss of jointing sand is also a problem (Table 4.3).

Maintenance Options:

The cause of the problem with the reinstatement needs investigating and appropriate action should be taken. (Chapter 3, Clause 3.4). The footway surfacing can then be relaid and jointing sand replaced. (Chapter 5, Clauses 5.38 - 5.46).

EXAMPLE 12

A footway has been built out into the road as part of traffic calming measures. A gap has now opened between the concrete blocks and the kerb and the surface of the pavers has become uneven. An adjacent reinstatement indicates that the problem may be due to the pavers having not been properly replaced on completion of the reinstatement.

Flowchart 1:

Is urgent treatment required?

The trip by the kerb is a safety hazard and should be temporarily taken out by ramping with bituminous material (Table 4.1 and Chapter 5, Clause 5.9).

Investigate cause of defect(s).

Defects appear to be due to a combination of overrun and reinstatement failure. If the reinstatement is within the HAUC guarantee period the appropriate undertaker could be requested to carry out repairs. The pavers should be lifted and an investigation made as to whether the problem is due to lack of foundation support, or confined to the surfacing (Chapter 3, Clause 3.4).

Flowchart 3:

To obtain an even surface the pavers will need relaying.

Maintetance Options:

As the area of pavers is small, the best solution would be obtained by lifting all pavers and relaying, using new pavers where necessary (Chapter 5, Clauses 5.39 - 5.43). If the foundation requires strengthening this can be carried out at the same time, reconstructing the foundation according to DMRB 7.2.5.3 (Heavy-vehicle design).