



Section 8
Maintenance
Second Edition 2004

8 MAINTENANCE

8.1 Introduction

Stone surfaces need to be maintained in order to protect the considerable civic investment, which they represent, and to ensure the continued safety of all users. This part of the Guide deals firstly with the important interaction between Design and Maintenance and then with common Defects and their repair, concluding with a short section on Cleaning. Further guidance is contained in BS 7533 part 11.

The long-term success of any streetscape project will depend to a large extent upon the priority given to maintenance issues. From the outset the future maintenance regime needs to be considered as an integral part of the Design process. The absence of consultation at this early stage has given rise to later problems when either design failures are revealed or conventional maintenance measures prove to be inadequate or inappropriate.

The need to understand each others needs and requirements points not just to timely public consultation, but to the necessity of co-ordinated training and mutual dedication of all members of the project team – including maintenance engineers and cleansing operatives.

Such integration of the project process should not imply designing only to the conventional maintenance criteria, but should encourage innovation on the part of designer, contractor and maintenance personnel that is based on sound agreed criteria, in which there is a common ownership of the project, persisting long into the future. Common problems resulting from faulty detailing, incorrect specification or poor workmanship can be reduced and misunderstandings over the cost and dedication to future maintenance that is required can thus be avoided.



Figure 8.1 Street Cleansing

Guidance

Maintenance personnel should be included in the project design team from the outset. The maintenance strategy should be designed, costed and approved as an integral part of the pre-contract phase of the project.

8.2 Aftercare

8.2.1 Contract Maintenance Period

The initial maintenance of new streetscape work will normally be the responsibility of the contractor and will typically last 12 months. It is imperative that contractors revisit the site and inspect the works regularly during this period so that defects are identified and rectified quickly and to ensure that, at the end of the maintenance period, all remedial works are undertaken to the satisfaction of the client, without delay. Experience has shown, however, that 12 months can be too short a period for certain defects to appear and, as is usual with the soft landscape components of streetscape projects, consideration should be given to extending the maintenance period for all elements to 24/36 months.

8.2.2 Maintenance and Management Manual

Both designer and maintenance engineer must be fully aware of the effects of aftercare maintenance operations in relation to the proposed design of the street.

During the design stage, all information relating to the future aftercare requirements of all parties involved in the life of the street should be collated. This information will form the basis for a Maintenance and Management Manual.

The purpose of this Manual is to establish a management strategy for aftercare and to determine in detail the operational guidelines for all those who care for the street. Such a document will be unique to a particular location, town or city, and must have the support and involvement of all stakeholders. A Manual will typically take some time, perhaps several years to fully develop. Consultation alone may take many months to ensure that all relevant parties have been contacted. Once in place a Manual must remain a 'living' document, constantly under review and regularly updated.

Experience suggests that Manuals written by single bodies in isolation from other relevant parties will not be successful. From the outset all stakeholders must contribute to the content of the Manual. In this way, the application of the Manual guidelines should not mean a sudden departure from normal practice, rather a gradual improvement in service delivery.

Once all stakeholders have accepted this approach, its effective implementation should be passed to a formally constituted Management Team who will have responsibility for the control and enforcement of the Management and Maintenance Guidelines. Not only must the team be committed to excellence in the delivery of a complete service, but it must have the full-delegated authority of its constituent Organisations.

A typical Maintenance and Management Manual should include detailed guidance on some or all of the following activities depending on the specific requirements of the area:

- Procedures for regular inspections of all paved areas
- Specification and Requirements for work by Public Utilities and general surface reinstatement
- Temporary Occupation of Roads
- Procedures for dealing with unauthorised works etc.
- Procedures for the reinstatement of non-attributable damage reinstatement
- Specification and sources of materials for repair/reinstatement
- Street and amenity lighting requirements
- Winter Maintenance procedures
- Procedures for refuse collection and use of litter bins
- Procedures for street cleaning
- Procedures for the maintenance of Street Furniture
- System for dealing with 'change' to the local environment
- Procedure for dealing with Public Liability Claims, with analysis of their causes
- Legal Procedures for the Use of the street.

(There will be a need to control the use of paved areas for events. The Management Team should establish protocols which govern the planning / operational aspects of events in terms of minimising the damage to the surface).

Guidance

A MAINTENANCE manual should be prepared as part of the planning and design stage of a project. It should include guidelines on the technical aspects of aftercare, together with procedures for the management of the street and paved areas.

The document should be regularly updated to reflect changes in the use of the area.

8.3 The New Roads and Streetworks Act

8.3.1 NRSWA Arrangements

Considerable research has been carried out to find ways of controlling excavations for the maintenance of underground services and avoiding the severe damage that is caused to stone pavements. The application of the New Roads and Streetworks Act 1991 (NRSWA) has resulted in Codes of Practice, which guide both the maintenance engineer and the companies undertaking the works. NRSWA also requires utility companies and Local Authorities to meet regularly in order to co-ordinate their activities.

However, excavation for maintenance purposes is inevitable in any street or public space and unfortunately NRSWA provides little assistance in ensuring proper standards of reinstatement of streetscape pavements. Whilst utility companies are required under NRSWA to reinstate any openings with materials matching those removed, they have considerable time to do this and the temptation is to temporarily reinstate openings with bituminous or concrete materials, then wait up to 12 months to carry out the final reinstatement. This is not acceptable in a high quality area where sustaining surface appearance is essential. It is a further annoyance that in many instances the original surfacing material has been 'lost' in the intervening period.

In addition, the shortage of skilled labour experienced in laying stone materials often leads to inexperienced contractors carrying out the work poorly. NRSWA does provide the opportunity for streetscape areas to be designated 'High Amenity' areas, but in practice this provides little additional control apart from raising the awareness of the Utility Companies to the special nature of a street or area.

8.3.2 Informal Partnerships for Utility Reinstatements

Improved legislation is undoubtedly required, but until this is enacted the most effective method of controlling the activities of Utility Companies will be through the creation of informal Agreements and Partnerships between the Companies and the Local Authorities.

This approach has been successful in a number of areas, where Local Authorities have approved a term Contractor with experience in lifting and laying stone paving. It has been possible to get agreement for the use of this experienced local Contractor by each Utility Company, with costs being recharged when required. The benefits to both parties are: -

- The local authority will accept the quality of reinstatement without further inspection and possible rejection leading to replacement.
- The surface will be permanently reinstated immediately after the works are complete.
- The utility companies will be able to reduce their maintenance liability burden as the local authority assumes responsibility for the quality of workmanship by their term contractor.
- A quicker response time to reinstatements by the term contractor.
- A "right first time" repair, which maintains the visual quality of the area and the structural integrity of the pavement, and meets public expectations.

This type of partnership operates well in certain areas of Scotland where all of the utility companies use the Council's term contractor for most excavations in High Amenity areas, having been satisfied that in the long term this represents best value for money.

Guidance

Pending improved legislation, informal partnerships should be encouraged to co-ordinate public utility activities, to use experienced local contractors and to improve the timing and quality of reinstatements.

8.4 Replacement materials

High quality stone paving represents significant investment and every effort is needed to ensure that new surfaces are maintained to the standard to which they were originally constructed. There will be failures; however, even with the best materials and replacement elements will be required at some time over the life of the project.

Delivery periods for many materials will be 2 to 3 months, or longer, if they have to be imported. In order to achieve early reinstatement, a stock of replacement materials should be provided out of the initial project budget. For example, an allowance of, say 10%, should be made within a works contract for the procurement and storage of additional paving and other predominant elements. Where specials or small quantities are involved a judgement is required, depending upon the degree of difficulty and time involved in procuring suitable replacements. Actual quantities will vary depending on the size and nature of the site.

Replacement materials need to be carefully and securely stored, preferably so that they are able to weather at the same rate as the completed pavement. This will allow quick replacement and give time to replenish the store.

If materials are not procured in this way, with the passage of time it may be difficult or even impossible to replicate colours and textures and sizes. This is particularly important if stone has been imported. It is essential that at the initial stage of purchase the full petrographical details of each stone along with accurate trade descriptions and quarry details should be recorded and kept in the maintenance manual for future reference.

Guidance

An allowance of, say 10%, should be made in Streetscape Contracts for the procurement and storage of replacement materials.

8.5 Common defects

8.5.1 Common causes

Over time, paved roads deteriorate in a variety of ways, depending upon the type of construction and cause of distress. When deterioration presents a safety hazard then maintenance becomes essential. Timely maintenance, in some instances can prevent deterioration progressing to a state where reconstruction is required. The majority of failures tend to be confined to the surface layers of paved roads, i.e. they concern the bedding and jointing that surrounds stone elements. Failures of the lower or support layers due to poor sub grade or low stiffness of the sub-base and roadbase are less common.

Factors likely to contribute to failure include, poor design and specification, poor workmanship, over loading, weathering, in-service wear and tear and lack of proper maintenance. Poorly matched materials following repairs may also be regarded as a defect at an aesthetic level. Much of this can be minimised through a planned maintenance programme, but some deterioration is inevitable and appropriate early intervention will be essential.

8.5.2 Descriptions of common defects

Descriptions and illustrations of common defects are given below.

Punching

Vertical downward movement occurs in and around wheel paths.

Punching shear is resisted by both the joints and bedding. The lower of the two capacities, joint shear or bed bearing will control the elements resistance to punching. The defect occurs in flexible and rigid surfacing.



Localised or isolated areas of punching are likely to be due to poor workmanship. More widespread punching is more likely to be due to inaccurate design.

Progressive cracking

Debonding of the jointing material from stone elements commonly leads to progressive cracking. The continuous action of heavy vehicle tyres on the elements dislodges and pulverises sufficient of the jointing material to cause a breakdown of the joint matrix. Inappropriate design and poor workmanship are likely causes. Factors likely to have contributed to this type of failure are:

- Early pavement trafficking
- Inappropriate laying pattern
- Elements not deep enough
- Low joint strength
- Poor compaction of the bedding
- Inadequate moisture content in stabilised bedding



Movement

If the homogeneity of the upper layer is broken, it is impossible to control lateral movement with joint widths greater than 10mm. Once the surface matrix is broken, the progressive impact of traffic tends to move the sets in angular directions, thus perpetuating the breakdown of the rigid surface. Ingress of water then adds to the problem. Rutting is common and, depending on the construction of the pavement, the underlying layers of the structure will gradually deteriorate.



Movement in Flexible Construction

When high traction forces exist such as occur with braking, accelerating and cornering, the surface profile and element orientation can be lost with flexible construction. The ability of the surface elements to move and the surface to deform without, necessarily, a loss of stability defines the layer as being a 'flexible' layer.



Loss of jointing material

Mechanical breakdown or loss of jointing material when using large elements such as flags or slabs allows the ingress of water. If the bedding layer is broken down by the action of water, freezing effects, lateral movement etc, then load-spreading ability will be reduced

Rocking of large elements

A stone element that is not evenly supported will rock when loaded. The problem is compounded as rocking pumps water and fines out from under the element, reducing the support further.

Rocking or loose elements result in higher stresses being imposed on surrounding elements due to dynamic effects. Over time such failure if left unattended will become progressive and pose a significant risk to pedestrians, so early intervention is essential.



Broken or damaged elements

Apart from being unsightly, cracking and spalling can become a hazard if it creates a trip.

Some paving materials, particularly those formed from sedimentary deposits, will naturally spall when exposed to the atmosphere, with the upper layers (only millimetres thick) de-laminating in early service life. This should not immediately be considered a failure as, in general, equilibrium is eventually reached although this might perhaps take as long as several years. Close monitoring of any such areas should be carried out.

It should be noted that some materials are selected for their weathering characteristics, where limited spalling is actually considered desirable. However spalling can occur during transport and laying, or less commonly, can be a fault in the material. It can result during manufacture, impact loading, abrasion and weathering. In these instances it should be regarded as a fault.



8.6 Treatment options

Maintenance treatment will depend on the type of defect and what has caused the deterioration. For some surfacings, topping up of jointing may be all that is required, but poor surface profile may require a site investigation to provide information on the condition of the pavement at depth. Suitable strategies can then be formulated based upon informed engineering judgement. Table 8.1 summarises some common defects, resulting problems and treatments.

Table 8.1 Common paved road defects and treatments

<i>Defect</i>		<i>Problem</i>	<i>Treatments</i>	
<i>Flexible</i>	<i>Rigid</i>		<i>Temporary</i>	<i>Long-term</i>
Loss of jointing material	-	Loss of stability	Replace jointing material	Monitor joints and keep topped up
Broken or damaged elements	Debonding of jointing material	Initiation of failure mechanism	Monitor/investigate	Replace jointing or reconstruct if poor design
	Broken or damaged elements	Unsightly, water ingress	-	Replace or reconstruct depending on severity
Missing elements	Missing elements	Unsightly, trip, water ingress	Fill holes	Replace element asap
Rocking elements	Rocking elements	Hazard to users	Relay asap	-
Spalling of arises or surfaces	Spalling of arises or surfaces	Unsightly, trips	-	Replace depending on severity
Widening of joints	-	Loss of stability, water ingress	Fill wide gaps if hazard	Relay elements and strengthen edge restraint if necessary
Depressions and bumps		Hazard for users	Fill or ramp. Contact undertaker if cause is failed reinstatement	Relay
Rutting		Hazard for users	Monitor, warn users	Relay
Slippery surface		Hazard for users	Warn users or restore texture	Clean, restore texture or renew surfacing
Surface contamination		Hazard for users and unsightly	Clean or neutralise	Replace surfacing if necessary
Vegetation		Surface slippery	Warn users, clean	Consider increasing frequency of maintenance
Water		Surface water	Salt if freezing	Relay surfacing to correct gradients and crossfall
		Blocked drain / gully	Clear blockage	Consider increasing frequency of maintenance

In general, it should be the aim to minimise repair times, in order to reduce the disruption caused. This commonly will involve the use of proprietary repair grouts, which give high strength in short curing periods. However, care must be taken with such materials to ensure that the high performance material is compatible with the original materials, particularly in respect of the stiffness and shrinkage properties. Useful advice on repairs to stone element surfacings and the frequency and method of safety inspections is given in the Footways Design and Maintenance Guide (TRL Application Guide 26, 1997).

8.6.1 *Lifting and relaying*

Relaying elements of flexible construction should be carried out in the same way as new construction (Section 7). Additional guidance for flags is given in BS 6677. Removing a damaged single element prior to relaying can be difficult, particularly if it is small, as breaking it out may disturb adjacent elements. It may be necessary to consider relaying a larger area, or to relay a full line of elements back to an edge restraint.

If the surface has been seriously deformed, elements will need to be lifted over the whole of the affected area and re-laid. In all cases a complete renewal of the bedding material should always take place. An experienced paver is required to execute a good reinstatement.

8.6.2 *Joint repairs*

Where elements are part of a rigid construction and degradation of the cement mortar joint has occurred, it will be necessary to refill the joint. If necessary the joint should be raked out, but this is both time consuming and costly. It may be more appropriate to use a small hand-held grinder with a dust collection attachment. Great care is required to avoid damaging the edges or surfaces of stone elements. Once the joints have been cleaned out they can be refilled with a mortar appropriate to the trafficking category (Section 4, Table 4.9). Care is required to confine the mixture to the joint and prevent staining of the surface. Trafficking should only be allowed once the mortar has gained the appropriate strength.

8.6.3 *Retexturing*

Re-texturing of non-sedimentary stone surfaces, which have become slippery due to vehicular or heavy pedestrian traffic can be undertaken by various methods including scabbling, sand or shot blasting, high-pressure water jetting or the application of weak acid.

Scabbling is slow but can be used successfully on slabs if done with care, especially where there is some form of surface growth. Debris is likely to be a hazard to passing vehicles and pedestrians. Sand blasting can be successful but results in a lot of fine particles and debris, which have to be removed separately, and again are a hazard to vehicles and pedestrians. Both methods are best suited to small areas where suitable working areas can be cordoned off.

On stone setts, flame texturing and bush hammering can be carried out in situ but again are slow and hazardous to the public. Trials have shown that an improvement in slip and skid resistance of up to 40 % can be achieved. Either method would be suitable for small working areas where the public can be temporarily excluded.

Shot blasting (preening) 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 reuse. Waste material is disposed of safely and at no risk to the public. The machinery comes in various shapes and sizes with large vehicle mounted units most suited to fast treatment to large areas. However, retexturing areas around street furniture and in irregular shaped areas can be difficult. The machinery is currently expensive to hire and would not be cost effective for small areas. In time, if this method becomes more widely used, the hire costs should reduce considerably.

Trials have shown that increases in slip/skid resistance of up to 60% can be achieved through shot preening. Rigid (bound) joints, if stable prior to the retexturing, should not be damaged by the process although the top few millimetres may be removed. It is not certain what would happen to flexible (unbound) joints but it can be reasonably assumed that there would be some degree of joint loss requiring refilling / resealing after treatment. It is recommended that small-scale trials be undertaken before using the method on large areas.

8.6.4 *Cleaning the surface*

In high profile streetscape areas it may be necessary to wash stone surfacings. This is commonly done by adapted small suction sweepers using hot water with added detergent. In addition to the cleaner appearance there can be an improvement in slip resistance.

There are a number of proprietary systems available on the market for the cleaning of stone surfacings. These include low and high pressure jetting, steam and freezing systems, but manufacturer's claims on their effectiveness on certain substances, in particular chewing gum, should be site tested before any considerable financial outlay is made.

In many European centres, stone surfaces are washed weekly with low-pressure water to remove general staining and to improve the appearance of the stone. This is not common practice in the UK at this time perhaps due to the amount of rainfall. However, during long dry spells, the surface appearance of stone surfaces can quickly deteriorate without some form of washing.

Experience of cleaning with motorised vacuum cleaning and of high-pressure water has shown that this can have a serious affect on a paved surface of flexible construction. Removal of unbound jointing material will quickly lead to the surface becoming unstable allowing water to enter. Unless regular maintenance budgets can stretch to very regular re-pointing of sand joints, the continued use of vacuum cleaning and high-pressure water should be discouraged, where unbound joint materials are specified.

It is commonly accepted that sand joints if left undisturbed for two years will become compacted and impervious. This suggests that if maintenance activities, which might damage the integrity of the jointing, can be deferred for this period, then there may not be a problem. This has not been verified through research for natural stone but comes from established concrete block paving knowledge.

Guidance

To ensure the chosen treatment is cost effective, consideration should be given to the maintenance history of the paved surfacing, its future use and the likely failure mechanism.

Early intervention should be a key objective of any treatment programme.

Stone surfacings will become slippery over time and an appropriate re-texturing technique should be used to restore skid resistance.