STREET ENVIRONMENT

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Summary:

It is said that we learn by our mistakes, and this paper is based on over 20 years of dealing with construction problems. In Britain, we have the British standards for laying and these are based on past and present knowledge, but this paper highlights some aspects that are crucial to the long term usage.

Surface depressions are usually blamed on the sand, but in over 90% of cases investigated, this is not the case, as illustrated in the paper.

Surface characteristics are examined for both 'slip' and 'skid' with more emphasis on the slip factor.

There are aspects that need highlighting, the edge and iron work detailing, the use of correct edge restraints and the availability of fitments.

Other aspects covered are the techniques on the laying of small element paving.

Introduction

Although this paper is entitled the Street Environment Design, it probably should be called the 'problem clinic.

We use current practice, and existing knowledge, to construct our roads and pavements, but we learn more from analysing performance failure and we are still learning.

This paper is based on 20 years of looking at problems and trying to resolve them effectively, and hopefully after today's presentation we will avoid many of the pitfalls experienced by others.

Surface Failure

In the United Kingdom, we have written standards, as codes, to give guidance to designers and constructors alike and these are used as a reference. The British Standards for 'Concrete Block Paving' BS6717 (1) and 'Precast Flags and Kerbs' BS7263 (2) give basic information on the construction of these products. This presentation will go into more detail than the standards, and although the paper and time allocated do not allow me to cover all eventualities, hopefully I can provide you with many ideas to minimise the risk of failure.

Considering concrete block paving, the bedding sand is an important part of the paving system, chosen incorrectly, this can lead to many problems, the most common being surface depressions nicknamed "Elephant Footprints"(3). This is where the sand has been broken down into smaller pieces, reducing the volume of the sand and creating a depression which causes possible loss of interlock, allowing water getting into this sand layer and mobilising further settlement under load. For the majority of applications a hard quaternary sand with a low silt content around 3%, will be more than adequate and but for very special cases, for example, bus stations, more care is needed in the sand selections. Do not, as some people have done in the past, specify a higher grade sand for a pedestrianisation schemes with a minimum overrun of commercial vehicles, when this quality of sand is not needed.

Of the surface depressions I have investigated , I would suggest that over 90% are not due to sand degradation but some other cause. In the first example, a dry lean concrete base was laid using a pavement train over a large area. This is just one example of where the base had cracked as shown in photograph 1.

This crack will never recover as the concrete is always shrinking. Sand will begin to fill this crack causing the surface to depress.
Another example of surface failure, after removing the blocks and sand, was that the base material was too soft and the blocks had punched into the base as shown in photograph 2.

Other causes , include sand laying thickness varying from 10mm to 100mm on the same construction area, bad detailing around changes in the base material and especially around iron work.

The solution to most of these problems is easily resolved. We must have the correct grade of roadbase and the surface tolerance, in my opinion, should be + or -10mm of the design level for all bases. The sand should have a thickness of 30mm and not more than 70mm but must be of uniform thickness. If you do not adhere to these recommendations you can end up with this type of failure photograph 3 - cracked blocks.
In this case, the base was an original road which had been 'planed' down to accommodate the overlay of blocks and sand. Many of the larger stone particles were protruding above the desired level. A very thin layer of laying sand was laid and then blocks laid on top and was no wonder that the blocks broke in two when trafficked. Also, on this site, the road was widened and instead of laying a similar base to the one which was already in place, the contractors laid a different base type all together. After trafficking, the client was concerned over the difference in the road surface.

Where we have a base that is likely to crack we must address the problem, either by spraying the surface with a flexible compound or by using a filter fabric. When using filter fabric care must be taken to use the correct grade. In this example, the crack was covered with a filter fabric and there was some water getting into the sand layer. From photograph 4, you can see the efficiency of the fabric is non existent because the very fines of the sand has clogged the fabric.

On examination of the sand, the fines content was in excess of 3% and the sand initially filled the crack but also the pores of the fabric and would not allow any water to pass through.

When sand enters in to a crack, the sand particles become wedged in the crack, the concrete cannot recover and the next time it shrinks the joint gets microscopically larger each time, allowing more sand to penetrate in to the joint.

Surface characteristics

An important aspect of the paving surface is the Skid/Slip resistance property. The material used in the manufacture and selection of the type of product is paramount to the performance. It is necessary to differentiate between slip and skid. Slip is for pedestrians and skid is for vehicles. Both have different mechanisms to consider, but both have micro and macro texture. Considering "skid" first ,on a black top road, the macro texture is the overall texture of the road and the tyres of the vehicle run on the stone in the surface. The micro texture is the roughness of the individual stones. In the case of concrete units, the macro texture is the space between the blocks and the micro texture is the surface of the unit. These are shown in simple form in diagram 1 and 2. There is no direct comparison of values between the two surfacing materials but specifiers request motorway performance levels of skid resistance values in low speed usage, e.g. up to 50km/h for our products, but this is a nonsense.

In the laboratory we can determine a value for both the unpolished and polished value of skid resistance. The method used is the Pendulum tester to determine the skid resistance value and a flat bed polishing machine.

Slip is much harder to evaluate as everyone of us has a different gait, different shoe conditions and different load characteristics. On a recent study, to observe the walking habit, it was interesting to try to anticipate when slip would occur.

The surface texture, aggregate type and state of cleanliness all affect slip resistance. The Greater London Council in their investigations of the different surfacing materials, produced an extremely useful table giving level of slip resistance and using these values and test methods similar to the skid resistance, we are able to put a minimum value of service level of 35. Please do not do, as one local authority did, decide to increase the slip value by nearly double and then proceeded to lay products with this value. Whilst this caused no problem to the 'abled bodied' people, it caused very serious problems to the 'less abled' people because the grip between the shoe and the paving surface was too good and caused much discomfort to the pedestrians who could not proceed easily. However, no material will provide a safe and comfortable surface if there is no maintenance programme. An example of this was a contact from a local authority engineer who said our product was causing people to slip and fall over. This came as a shock to us as the past performance of the product used all over the country indicated, it as a product that does not polish.

On investigation, the location of the site was outside the local fish and chip take away shop and it was obvious that the greasy papers and food had been dropped on to the pavement. When we asked "When did you last clean the surface?" the reply was "We have not". A surface wash was carried out on the area and when the surface was tested with the pendulum tester the results of the test matched the values of the paving elsewhere on the site. To maintain good properties, the surface must be looked after and have a regular maintenance programme.

Detailing

In the laying standards we specify joint widths and by filling the joints with sand, interlock is developed and to maintain this we need to constrain or restrain the paver units or flags, by fixing an edge restraint as illustrated in diagram 3.

To provide edge restraints manufacturers have an extensive range for all types of loadings. These can be in the form of preformed plastic edgings, small length kerbs, standard kerbs or high containment kerbs.
Photograph 5 and 6 illustrate the wide range that will deal with all situations. To facilitate going round corners, crossings for vehicles as well as complimentary drainage units there is a wide range available to minimise problems and to provide a suitable means of finishing the construction..

Obviously, these types of units have limited applications, being more suitable for car and light commercial use. But for heavy commercial vehicles there are standard BS7263 kerbs and the range is illustrated in diagram 4 or if a more aesthetically pleasing surface texture is required, there is a range of kerbs with the associated droppers radius and quadrants available in many colours to suit the location.

Where buildings need to be protected, in particular dock and commercial areas then there is a product available.

Construction

For block paving to give good life and service they must be correctly laid - BS6717 : Part 3 provides the information and there are some basic consideration to observe.
Having the restraint in place, let's investigate the laying problem. The screeding of the sand is all important to obtain a uniform thickness and density. As the sand is screeded out a surcharge

is built up at the back of the screeding board, photograph 7, but when screeding begins there is no surcharge and it takes up to half a metre to build it up, it is necessary to apply a thin layer of sand to ensure that the sand layer, when compacted, is in the same order of volume.

It is not always possible to fit full blocks in, so they need to be cut. In the standard B.S. 6717, it states that the minimum cut is a third of block, this is to avoid small bits being sucked out by vehicles and suction cleaning machines and therefore opening up the area to ingress of water and the loss of interlock. Answers to these problems are quite straight forward - we 'in-board' cut units - in basic terms we introduce a half block into the pattern and then cut a full block to fit and the photographs 8 and 9 illustrate several examples of this on a straight kerb line and a curve respectively.

Quite often, specifiers wanted straight lines both longitudinally and transversely across the road contractors obliged by opening up the joints. The problem in this example has a camber, crossfall and everything else associated with road levels. The road was introduced to be a low use road but turned out to be a very busy road for buses and commercial vehicles resulting in blocks being pushed up tighter. The way to restore the pavement to a usable road surface was to remove some blocks, relay with normal joints and fit two cut blocks in the gap and this is called stitching.

In all our areas of roads and pavements it would be ideal not to have inspection chamfers located in our pavements, but in reality, we have. The question of covers and bringing paving units up to them can be a nightmare. Blocks lend themselves to being laid to a vertical face, so although not attractive, a concrete ring is one answer. The size and quality of concrete is essential not like this, as shown in the photograph 10, not only is it cracked but look at the concrete or should I say mortar.

To overcome this, there are many different covers and frames and the photograph 11 illustrates one of the many covers especially designed for this purpose. The major problem experienced on site is not the block fitting against the cover and frame, it is the fixing down of the frame.

When you have different materials there is bound to be movement, so that in situations like this, the need to stop the sand from escaping into the chamber is paramount and this can be simply achieved by the use of a filter fabric as shown in this diagram 5.

The use of accessories can overcome particular problems on site, for example instead of attempting to cut blocks against the restraint, use the mitre block and then cut the normal block into the mitre block. There are many examples of these accessories being used all have been developed to overcome problems on sites.

When laying small element concrete flags, on a sand bed, in accordance with BS7263 : Part 2, the joint widths should be between 2-4mm.This is difficult to maintain especially as flag generally do not have spacers on the side. What is available, is purpose made special spacers to maintain the joints and these are positioned on the underside of the flag.After laying the flags, compact in the normal way, leaving the spacers in place as shown in photograph 12. An alternative method is to space from the top and these temporary spacers are remove after the sand has been brushed in to the joints. Compaction is carried out in the normal way.

Research and practice have shown that paving flags cut into two can be used to lay a half bond pattern, therefore breaking up the straight line effect and, especially, on slopes, slow the water flow down.

Tactile flags have proved to be useful in giving guidance to the blind and partially sighted and therefore it is essential that they are used correctly.
With the greater awareness of the needs of others, with more and more emphasis on crossings, there is as range of special dropped radius kerbs and to construct flag pavements we need to cut the flag and 'bend' accordingly. On corners and other dropped crossings BS7263 gives guidance on how to treat them.

Conclusions

On detailing and how to overcome problems on site, most manufactures have available, a variety of drawings of problems or queries that have been raised, with suggestions on how to overcome the problem.

As part of an ongoing development of passing on information and to help, we have designed a computer programme to run in Autocad to save time on the intricate detailing of hard landscape and drainage details and this is available to all our customers.

To obtain the best solution for construction and good practice it is essential that producers, specifiers and constructors talk together, so we can achieve our aims in providing a surface that is durable, safe to use and has a long life.

References

1.BS6717: Part 3 1989 . *British Standards for Precast Concrete Paving Blocks Part 3; Code of Practice for laying* British Standards Institution London

2. BS7263 Part 2 1990. *British Standards for Precast Concrete Paving Flags Part 2. Code of practice for laying.* British Standards Institution London.

3. Laying course sand for concrete block paving.1988 *Dowson and Lilley Pavitalia* Rome

Photograph 1



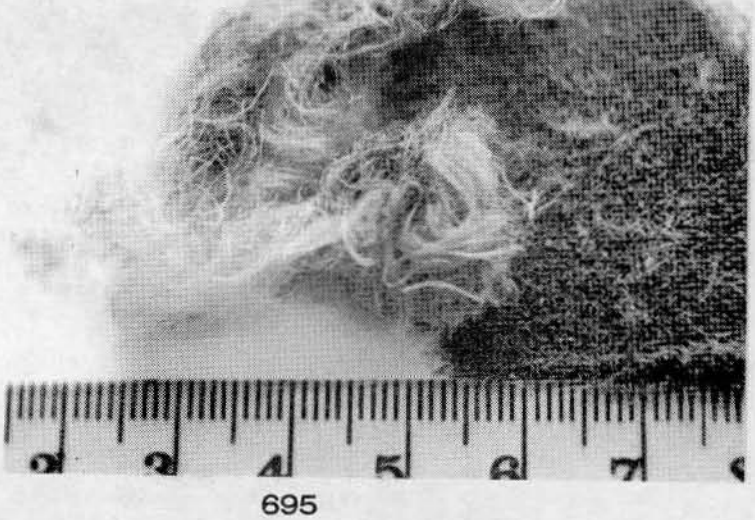
Photograph 2



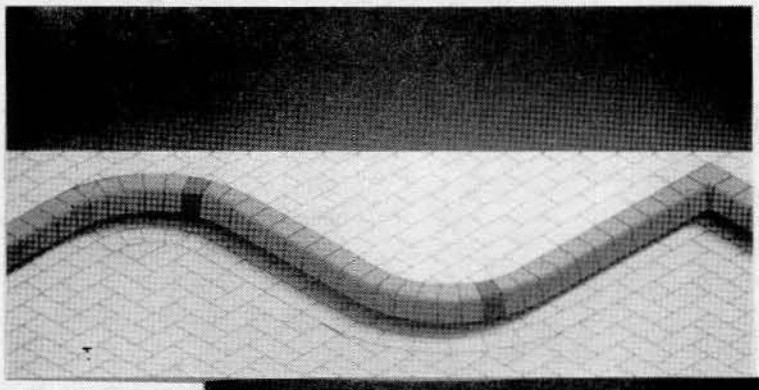
Photograph 3



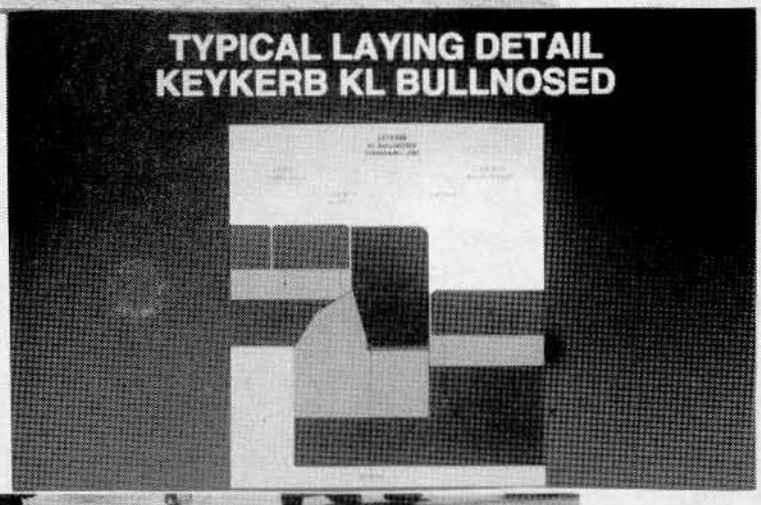
Photograph 4



Photograph 5



Photograph 6



Photograph 7



Photograph 8



Photograph 9



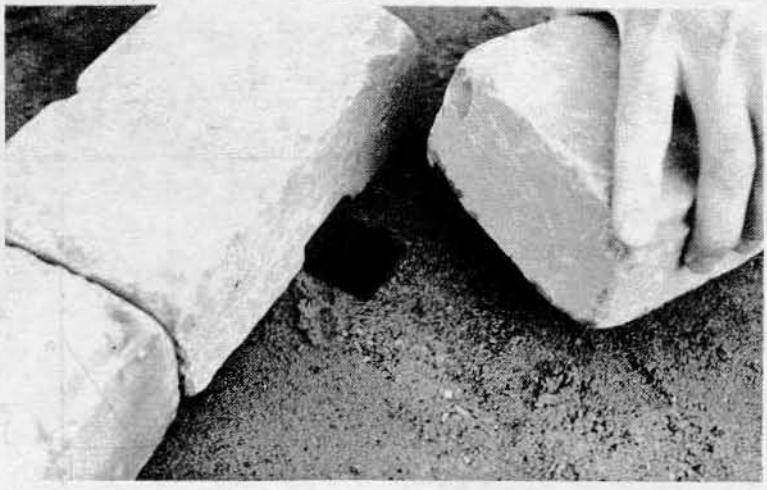
Photograph 10

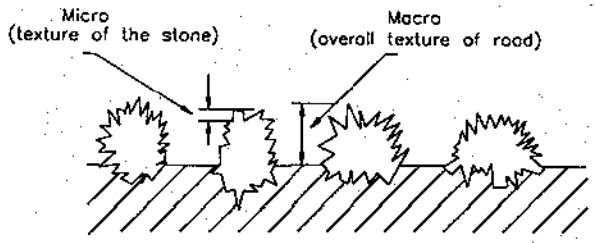


Photograph 11



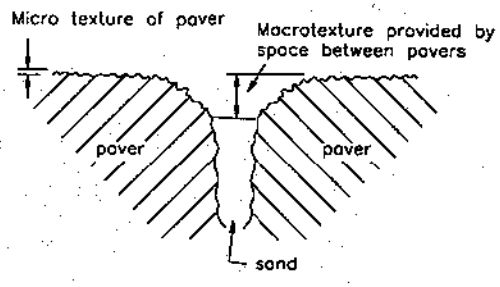
Photograph 12





Microtexture and macrotexture of bituminous surface

Diagram 1.



Microtexture and macrotexture of small element paving

Diagram 2.

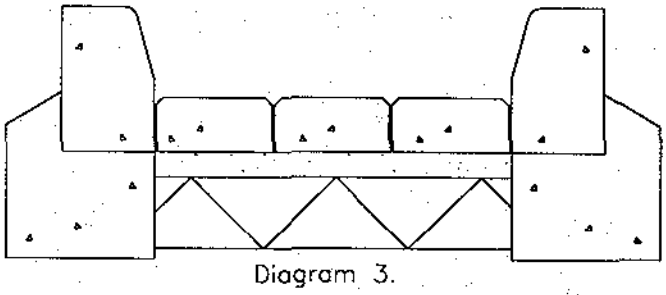


Diagram 3.

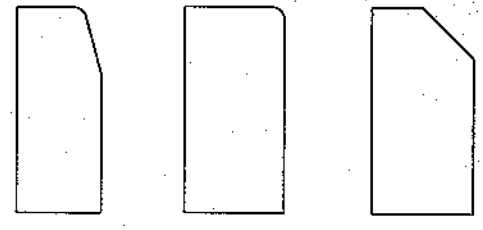


Diagram 4.

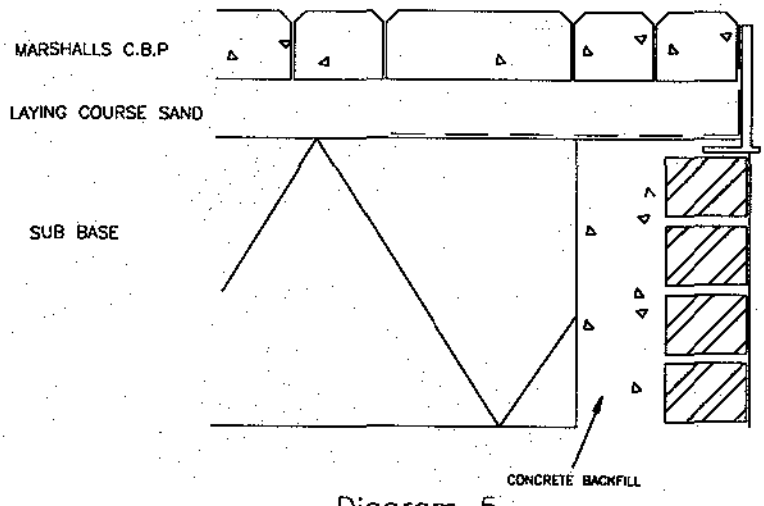


Diagram 5.