BLOCK PAVING
TO SEAL OR NOT TO SEAL ?

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Summary

The concept of sealing pavers was introduced by Emery eight years ago when erosion of jointing sand from pavers used on aircraft pavements was perceived to be a serious problem. A urethane pre-polymer sealer/stabiliser was specifically formulated to prevent this form of erosion. It was later established that this sealer was also effective in:

- Strengthening pavements
- Avoiding weed growth in joints
- Enhancing appearance of pavers
- Preventing stain penetration into paver surfaces
- Inhibiting infiltration of water and fuels through paver joints

There has been a rapid increase in sealers available for use on pavers and information is given on the nature and function of these products. Methods of application of sealers are described with reference made to Health and Safety requirements.
This paper will identify the particular areas of pavers that will benefit from sealing and present the case for sealing of pavers.

1. Introduction

Until recently, there was a widely held view that the joints between block paving seal and stabilise with time and use. However, it is now accepted that only a partial natural sealing of joints may occur due to accumulation of dust and detritus at the surface of paver joints. Furthermore, this natural '*sealing*' process provides only a very weak bonding within the surface of the jointing sand to prevent its erosion. Many areas of block paving do remain pervious and vulnerable to jointing sand erosion and a positive sealing process is necessary.

Research in the USA by **Smith [1]** has shown that paver surfaces should always be assumed to permit the infiltration of water. He concludes that concrete block paving trafficked by vehicles will not always allow joints to fill with detritus and that the pumping action of tyres may reverse any sealing action that may take place.

Four forms of jointing sand erosion were identified by **Emery [2]** and he developed a low viscosity polymeric sealer to counteract these erosion problems. Besides stabilising the jointing sand, the sealer also:

- Strengthens pavements
- Resists penetration of water and fuels through paver joints
- Resists stain penetration and weed growth in joints

Why seal pavers?

It is the authors' contention that sealing concrete block paving will provide the benefits discussed below. Of course, there are situations where the exclusion of water from the pavement construction may be unimportant. Indeed, there are projects where porous pavers are necessary for reducing runoff and replenishment of aquifers and sealing would therefore be inappropriate.

Retention of sand in joints

Block paving provides, perhaps, the most durable form of surfacing for any flexible pavement. Its unique self-articulating structure will normally not require expansion joints and may effectively be used on domestic driveways and aircraft pavements using virtually the same simple construction methods. However, to provide and maintain interlock, defined by **Knapton[3]** as "...the inability of an individual paver to move independently of its neighbours", it is essential to retain sand in joints.

The four forms of jointing sand erosion identified by **Emery [2]** are:

(i) *Jet blast and propeller wash from aircraft engines*
(ii) *Use of vacuum sweepers and high pressure cleaners*
(iii) *High velocity water flow*
(iv) *Degradation and pumping of laying course materials*

A wide ranging report on the worldwide use of pavers for aircraft pavements has been prepared by Knapton and Emery for the UK Civil Aviation Authority **CAA [4]**. Among the recommendations given in this report is that erosion of jointing sand by jet blast should be minimised by use of joint stabilising material, i.e. sealers.

Various materials were used by Emery to overcome jointing sand erosion, some of which provided only a temporary solution to the problems. The most effective means of sealing and stabilising jointing sand was found to be a specifically formulated, clear liquid urethane pre-polymer that retains a high level of elasticity after polymerisation.

Prevention of ingress of water through joints

An essential requirement of most pavement surfaces is to exclude water from the underlying pavement surface. That 5% of a paver surface is made up of joints, makes the likelihood of infiltration of water inevitable unless some form of sealing is provided. Investigations by **Knapton [5]** into the effects of water penetrating concrete block paving concluded that:

1. Ingress of moisture through block paving can have a marked effect upon the structural performance of the pavement
2. Under an adverse combination of water, material and traffic, a concrete block pavement can develop significant levels of rutting after a few thousand 8000 kg standard axles, even though the requirements of **BS 7533 [6]** are satisfied
3. The application of a polymer sealer to a fully granular concrete block pavement can result in a significant improvement in pavement performance.

In-situ infiltration tests by **Emery [7]**, using a 140 mm dia. falling head permeameter, on an area of unsealed pavers have shown that, in simulated flood conditions, i.e. with a depth of standing water of approx. 40 mm, the infiltration rate was 300 mL/sec. This equates to approximately 1000 litres of water penetrating one square metre of pavers in one minute. For sealed pavers under similar conditions the infiltration rate was 15 mL/sec.

Laboratory research by **Shackel [8]**, in which he simulated rainfall of approx. 45 mm per hour on newly laid block paving, indicated that up to 65% of the rainfall penetrated the joints of the pavement. On block paving, sealed with a water based acrylic sealer, he concluded that infiltration could be reduced by about 50%.

The foregoing corroborates the assertion that sealing of pavers will diminish the ingress of water through paver joints.

Strengthening of pavements

Recent work by **Knapton & Algin [9]** provides a mathematical approach to the understanding of the concept of interlock. It confirms the importance of maintaining sand between joints throughout the life of a pavement surfaced with pavers to transmit shear stresses between neighbouring pavers. This, they conclude, may be achieved by jointing sands being treated with pre-polymer liquids.

Prevention of infiltration of fuels through joints

Concerns have been expressed by Petroleum Officers that ingress of fuels through joints may present a potential hazard if fuel accumulates in the laying course sand. Environmental Agencies have also stated that there is a risk of contamination of underlying water supplies if fuel and other pollutants are allowed to pass through a pavement. These matters have been addressed by **Emery [7]** in a previous paper. His conclusions are:

(a) Paved forecourts which have not been sealed may give rise to unacceptably high 'Lower Explosive Levels'.
(b) Sealing of concrete blocks reduces infiltration of water and fuel spillages to an insignificant level.

Many petrol station forecourts in the UK, surfaced with concrete blocks, are now sealed on instructions from Petroleum Officers. Figure 1 shows sealing work being carried out at a typical petrol station forecourt.

Fig. 1 - *Sealing Pavers on petrol station forecourt*

Ease of cleaning pavers

All paver products will inevitably be affected by general dirt, spillages and tyre marks and will require frequent cleaning. In the UK, the introduction of the Environmental Protection Act in 1991 set standards for cleanliness for town and city centres. Part of the Act called for designated areas to be cleaned and swept as much as six times a day.

The extent and depth of stain penetration is affected by the porosity of pavers. The level of porosity of pavers is not normally specified and no mention of it appears in **B.S. 6717[10]**, which sets out requirements for physical properties of concrete pavers. A typical value for the porosity of concrete pavers is around 3% and will vary due to cement content, type of aggregate and additives used, water/cement ratio of mixes and surface texture of the paver produced. Experience has shown that sealing pavers will reduce their porosity and inhibit stain penetration.

In the USA, the Interlocking Concrete Pavement Institute **ICPI [11]** has published a comprehensive guide dealing with cleaning and sealing of pavers and affirm that one of the functional advantages provided by sealers is that they can protect pavers from stain penetration.

Types of sealers available

A range of water and solvent based polymer sealers is now available for use with concrete block paving, for improving the appearance and performance of pavers. As block paving is categorised as a flexible surface it is essential that the sealer to be used should also be flexible. Three types of sealer are in general use and may be characterised as follows:

(i) Water based emulsions

Water based polymers are emulsions having very small particles dispersed in water. These rely on penetration of solids in suspension into the surface of pavers and into the jointing sand. Additionally, they rely on the evaporation of the water to permit the particles to bind with the concrete and sand. Whilst they will form a film on the surface of pavers, only a weak bonding is achieved within the jointing sand due to the solids being filtered out.

They tend to be slow curing at low temperatures and high humidity, have poor water resistance, retain dirt and may whiten when wet.

(ii) Solvent based Acrylic

These will, in the short term, enhance the colour of pavers, provide stain resistance and generally create a glossy finish to the surface, providing an aesthetic appeal for some individuals and an unnatural look for others. The main disadvantage of this type of sealer is that, in general, they do not have good elastomeric properties.

(iii) Moisture cure Urethane

The most effective sealer/stabilizer having good long term performance, has been found to be a low viscosity urethane pre-polymer, having a solids content of approximately 20% carried in a hydrophobic solvent, whose curing is catalysed by moisture in the substrate and in the atmosphere. This type of polymeric sealer is highly elastomeric, having an elongation at break in excess of 400%. The final polymer has an amount of cross-linkage present such that it provides good resistance to solvents, (e.g. fuels and de-icing materials). It effectively seals and stabilises jointing sand and imparts a natural, non glossy finish to the surface of concrete blocks with a single coat application. Additional coats will provide a gloss finish, if desired.

Methods of application

Whichever sealer is used it is essential that the manufacturer's instructions regarding application are heeded. Most sealers will contain hazardous substances and strict compliance with any health and safety guidance is essential.

The area of block paving to be sealed will usually determine the method of application to be used. Figures 2,3 and 4 below show proven methods that may be used for treating small to very large areas of block paving.

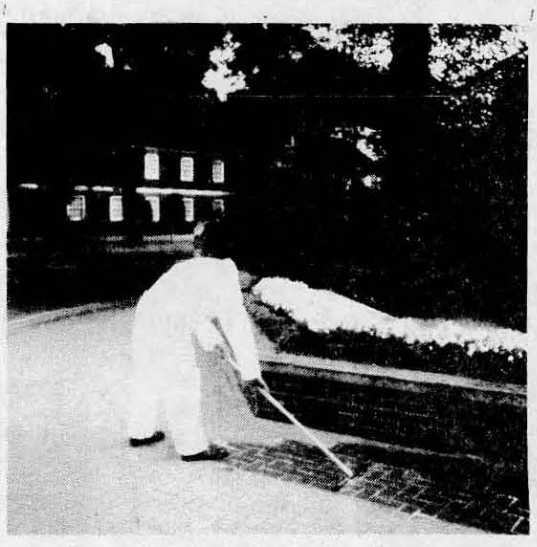

Fig. 2 ***Manual application using a foam rubber squeegee - For small areas***

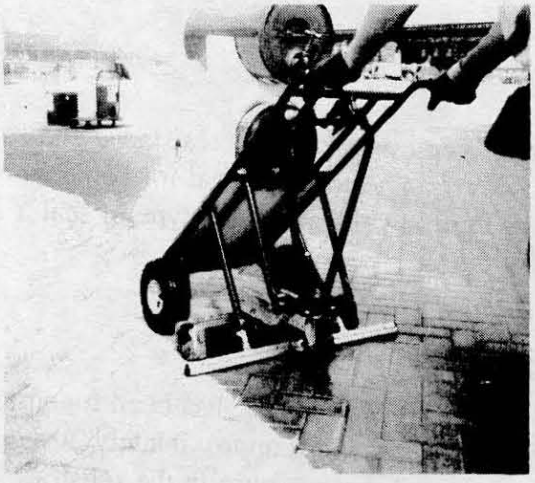

Fig. 3 - ***Gravity feed appliance For medium sized areas***

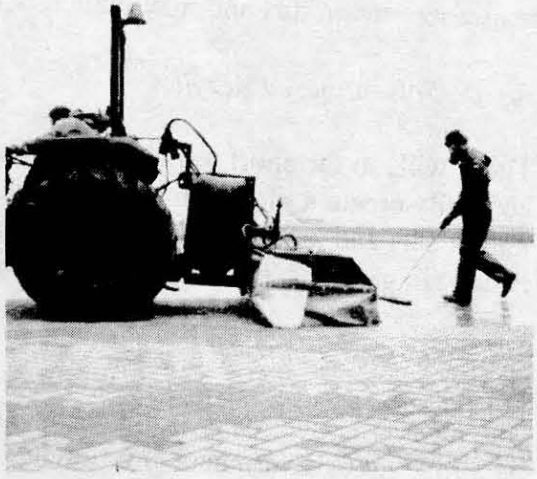

Fig. 4 - ***Confined spray equipment For large areas***

Conclusions and recommendations.

Three types of sealer are generally available for use with block paving, i.e. water based, solvent based acrylic and moisture cure urethane. Experience has shown that the urethane sealer is the most effective in reducing absorption of pavers and stabilising jointing sand.

This type of sealer, which has a long term proven record on projects varying from domestic drives to heavy industrial pavements, will:

- Reduce surface porosity thereby resisting penetration of stains and assist subsequent cleaning.
- Strengthen and maintain performance of pavements by enabling pavers to transmit shear stress to neighbouring units by maintaining sand in joints.
- Inhibit ingress of water and pollutants through joints.
- Inhibit weed growth between joints.
- Stabilise jointing sand and prevent erosion of jointing sand from:

  Jet engine blast on aircraft pavements.
  Use of vacuum sweepers and high pressure jet cleaning equipment
  Turbulent water flow.
  Degradation and liquefaction of laying course sand due to ingress of water.

Most sealers contain some hazardous ingredients and it is essential they are applied strictly in accordance with manufacturers' instructions, with special attention given to health and safety needs.

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