

CBP SEALING STRUCTURAL AND ENVIRONMENTAL BENEFITS

AUTHORS

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ABSTRACT

Whilst sealing block paving is neither new nor innovative the benefits thereof are fast becoming an integral part of the design and specification of small element paving systems. Emery, accredited with the introduction, formulation and subsequent application of urethane pre-polymers, was quick to foresee the additional benefits of sealing over the above its original use for aircraft pavements. The benefits now widely accepted are:

- (1) Stabilises jointing sand thus eliminating sand erosion.
- (2) Inhibits water/fuel ingress.
- (3) Inhibits growth of weeds/grasses.
- (4) Avoids staining of paver surface.
- (5) Enhances appearance of pavers.
- (6) Reduces maintenance.
- (7) Prevents efflorescence.
- (8) Reduces cost of paving system.
- (9) Simple to apply
- (10) Reduces Whole life cost.

1. INTRODUCTION

Over the past decade specialist pre-polymer urethanes (SPPU's) have been utilised in many different environments; both at civil airports (Heathrow/Sapporo) and military airfields (RAF Benson/NATO Ankara), transshipment terminals such as Mina Raysut Port, Oman, Disneyland Paris and McDonald's restaurants in the UK and Central Europe. Whilst all of these environments required the introduction of a sealer in the first instance to stabilise the jointing sand, other benefit needs have been identified.

In the case of both Heathrow and Sapporo, sand erosion by jet thrust and rotor-down wash was needed to be prevented as well as eliminating the infiltration of hydrocarbons. At Mina Raysut Port, Oman (465,000m²), the key issues were firstly sand erosion from seasonal tidal flows and more importantly the prevention of the infiltration of rainwater during monsoon conditions. The design engineers (Han Padron of New York, U.S.A.)

believed the specification of an SPPU was critical to ensure the avoidance of bedding sand liquefaction and degradation, which could potentially result in pavement failure.

The partial stabilising of the joints between block paving may, be achieved by relying on the accumulation of dust and detritus. However the above mentioned environments, by their very nature prevent this from taking place. It was concluded that concrete block paving trafficked by vehicles may reverse any natural sealing action owing to the sucking/pumping action of tyres [1].

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 critical that the sealer to be used should also be flexible. Four types of sealer are in general use and may be characterised as follows:

1.1.1 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 sand particles to bind to each other and to the concrete block sides. 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.

1.1.2 Solvent Based Acrylic

These will in the short term enhance the colour of pavers, provide a degree of 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 disadvantages of this type of sealer is that, in general, they do not have good elastomeric properties. Furthermore they will become softened when exposed to hydrocarbons.

1.1.3 Specialist pre-polymer urethanes (SPPU's)

The most effective sealer/stabiliser having good long term proven performance has been found to be a low viscosity urethane pre-polymer, carried in a hydrocarbon 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%. SPPU's owe their hardness, tensile strength and elastomeric properties to their ability to bring together polyether polyols both linear and branched having medium to high molecular weights. The final polymer has an amount of cross-linkage present such that it provides excellent resistance to solvents, (inc. 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. Some manufacturers provide such sealers with a high solids content and are thereby able to offer a written guarantee against staining from engine oil.

1.1.4 Hydrated Polymer Glues

This method of stabilising jointing sand is achieved by using a single sized jointing sand combined with a hydrated polymer glue as the binder. When wetted, following the placing of sand in the joints, the 'glue' is activated and weakly binds the sand particles together in a partially flexible state.

2. SEALING OF PAVERS

The concept of interlock and the importance of jointing sand cannot be overstated. Work carried out by Knapton and Algin [3], provides a mathematical approach to understanding and interpreting the concept of interlock and demonstrates the importance of maintaining sand between the joints throughout the life of the pavement in relation to its ability to transmit shear stresses between neighbouring pavers. They confirm this may be achieved by treating the jointing sand with an SPPU.

Fast-track construction constraints dictate more often than not that it will be heavily trafficked (pedestrian or vehicular) immediately the system is opened it is now commonly accepted that the sealing of CBP will eradicate the following problems

2.1 Sand Erosion

As described above, any pavement system is dependent on interlock and in turn, jointing sand retention. Erosion of jointing sand takes many forms:

- (1) The modern pedestrianised environment dictates that such an area must be maintained and cleaned on a daily basis, this being achieved by the use of aggressive vacuum sweepers commonly having a suction of air velocity of 60m/s. Areas such as Town centres and shopping malls are usually opened to traffic upon completion and therefore liable to immediate sand extraction by vacuum sweepers.

These problems may be exacerbated under canopies and internal malls. Sealing with an SPPU 24 hours prior to opening will ensure retention of the jointing sand. Some cleaning regimes are so stringent they dictate that certain public areas must be swept/cleaned as much as six times a day (Environmental Protection Act 1991, England & Wales).

- (2) Turbulent high velocity water flows created in and around gullies, in drainage channels and more commonly on inclines have significantly greater sand erosion at the bottom of the gradient or water outlet. The action of this water flow can remove the jointing sand and lead to unstable conditions in the laying course. This form of erosion has been investigated [4].
- (3) Flooding and tidal waters can have a destructive effect. Both Promenades at Paphos in Cyprus, and Egremont in the UK suffered extensive damage due to high tides and storms. In both cases pavers themselves were simply washed away. At Egremont following repairs the promenade was treated with an SPPU. Thereafter, despite being subjected to storm and tidal waters leaving flood water 1m depth, there has been no subsequent damage.

- (4) Jet and pressure washing are commonplace as a quick and effective way of cleaning the paver surface, adversely the action of the washer will lead to sand removal from the joints. Trials held by the London Borough of Camden on the 7th February 2000 with the use of SPPU's in stabilising pavers involved practical test under the supervision of their Chief Engineer D. Gonsal MRI. C.Eng.,MICE whereby a concentrated jet of water at a pressure of 200 Bar was repeatedly directed at the joints over a test area of 10m². It was found that the SPPU (after polymerisation) had bound the sand to the sides of the pavers to the degree whereby it remained fully intact and unaffected.
- (5) Aviation facilities both military and civil suffer from extreme sand erosion via jet thrust and rotor-down wash. It has been reported by J Emery [5] that, in excess of 1cm of jointing sand can be removed by this action. Jet engine exhausts can create velocities of approximately 300m/s. In extreme cases such erosion can create a severe risk of Foreign Object Damage (FOD).

2.2 Ingress of Water

The infiltration of water through block paving is inevitable, as 5% of the paver surface is made up of joints. Investigative work carried out by the co-author [6] concluded that:

- (1) Ingress of water through block paving can have a detrimental effect upon the structural performance of the pavement.
- (2) Under an adverse combination of water, unsuitable bedding sand material and traffic, concrete block paving can develop significant levels of rutting after a few thousand standard axles.
- (3) The application of an SPPU to fully granular concrete block pavement can result in significant improvement in pavement performance.

2.5 Pavement Installation and Whole Life Costs

In a recent paper the co-author [10] demonstrates that a range of pavements could have been installed with lower quality bedding material thereby reducing the overall cost of the paving system. The application of an SPPU will it is suggested, ensure the pavements' stability.

When taking into account the whole life cost of a paving system in terms of maintenance budgets; these amounts can be significantly reduced to such a level whereby the cost of the pavement system is effectively reduced.

3. CONCLUSION

The use of SPPU's world-wide thus far has been to resolve perceived specific issues that have arisen following installation of a pavement surfaced with pavers. It is the authors' contention that sealing a paver pavement has much more far reaching benefits than has previously been considered. These are chiefly those environmental factors which are commonly associated with pavements surfaced with pavers. Because pavers are used to surface a wider range of end use pavements than are many other pavement surfacing materials, there is a commensurate increase in environmental factors which can affect paver pavement adversely. Many now consider paver joints to be the weak link in the system. Many who have investigated paver failures have concluded that jointing defects have been the underlying cause of the failure. The use of high deformation polymer based stabilisers/sealers significantly enhances the strength,

durability and fluid resistance of joints and thereby enhances the performance of the entire pavement. For many categories of pavements, the use of SPPU's is the cost-effective way to significantly enhance many important properties of paver pavements. Because these materials have now been in service for over 12 years, they should be considered to be a normal part of paver specification for many categories of pavement. Experience to date has been favourable with no examples of failure associated with stabilisers. Specifiers of the following categories of pavements should include SPPU's in their pavements:

- (1) Pavements which are to be subjected to vacuum sweeping.
- (2) Aircraft pavements.
- (3) Heavy duty pavements.
- (4) Pavements which incorporate areas subject to high velocity water flows.
- (5) Heavily channelised pavements.
- (6) Pavements subjected to unusual environmental effects.
- (7) Pavements on severe grades.
- (8) Pavements over moisture susceptible materials.
- (9) Pavements used by animals.
- (10) Pavements serving areas where food is consumed.

Whilst stabilisers will be beneficial in other categories, it is the above where cost savings are likely to be even greater.

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