PLASTIC SHEETS ARE DETRIMENTAL TO FLEXIBLE SEGMENTAL PAVING

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SUMMARY

Segmental block paving is increasing in popularity in southern Africa at an exciting rate. Many small paving businesses run by artisans have been set up to serve the domestic market. Artisans with practical building experience try to transpose rigid concrete paving practise to flexible segmental paving. Good rigid practise requires the use of plastic sheeting to stop the ingress of moisture onto the concrete slab. Similar principles of using plastic sheeting under the bedding sand within flexible pavements is very detrimental to the serviceability and durability of block pavements.

The provision of plastic sheeting under the bedding sand is considered to be a desirable optional extra by those who do not understand the design principles. Indeed some proudly advertise this as a desirable additional-cost option. Another reason mooted for the use of plastic sheeting is to stop the growth of weeds in the pavement.

This paper reviews the misguided concepts for the use of plastic sheeting in flexible paving, by comparing the different design principles of flexible paving and rigid-concrete technology. An optimal range of joint width is identified for suitable jointing materials. Diagrams show the effect of torsional and other loads on flexible pavement systems where plastic sheets have been used. The detrimental effects of water entrapment above and below the plastic sheeting are also shown in diagrammatic form. Loss of structural intimacy of the flexible paving system around the plastic sheeting is also discussed.

INTRODUCTION

In the Republic of South Africa and in the neighbouring countries of southern Africa, the popularity of paving has led to the establishment of dozens of small paving companies. Often the founder of the company who is its working foreman was a practising construction industry tradesman who set himself up in business as a paving company. Such companies often hire several labourers who together with the working owner-foreman provide a paving service principally to the domestic market.

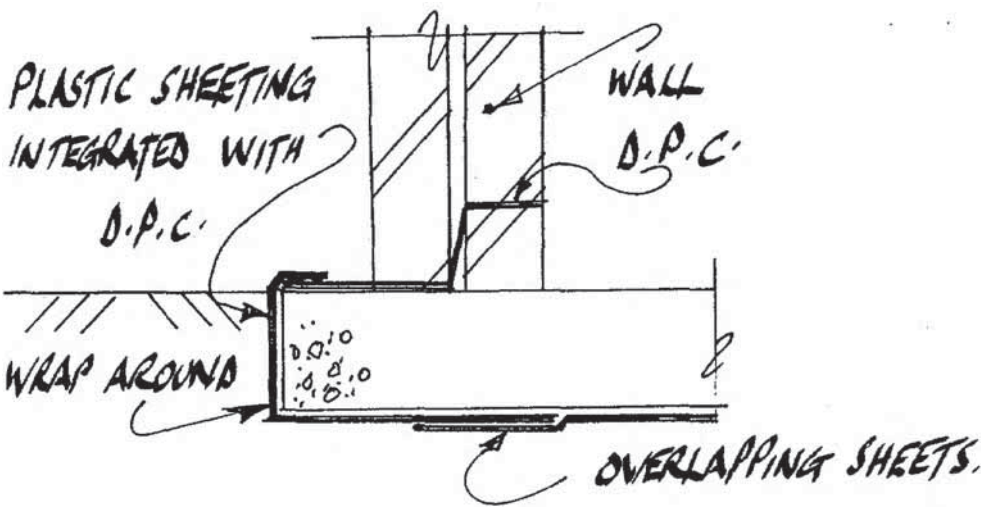
It is an anomaly that in this part of the world no formal training or registration is currently needed to establish a small paving business. Most paving companies are no doubt sincere in trying to provide the best practical service possible. However the paving industry has suffered, and continues to be less effective than it might be, due to these well meaning but inadequately trained people.

Their is a belief among many that plastic sheets laid under the bedding sand is beneficial for stopping weed growth and somehow protects the blocks from premature failure due to various unspecified "ground effects".

In the marketing of segmental block paving by these small paving businesses in the competitive domestic market many offer, as a supposedly desirable extra, the inclusion of plastic sheeting to be laid under the bedding sand. Householders are led to believe that the extra money charged for the sheeting is warranted by better in situ service, and ultimate life or durability, of the paving.

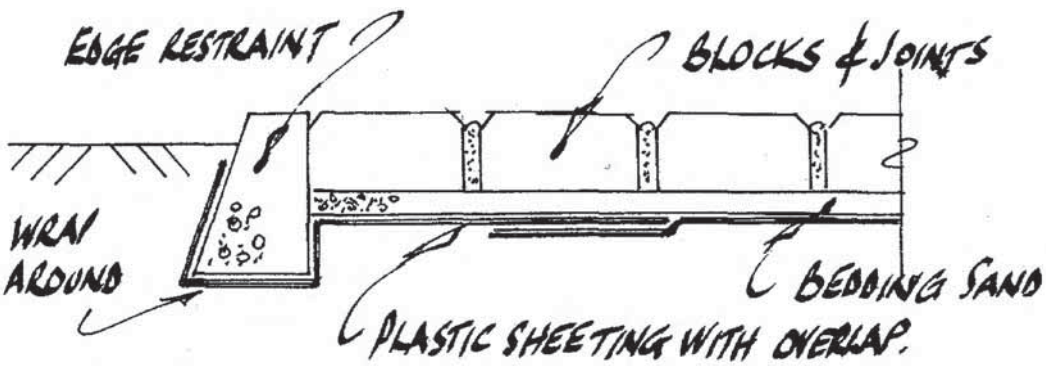
Small paving companies are often familiar with, and have cast many rigid concrete floors. They are not aware that different design principles apply to those used in the design of flexible segmental paving systems. Plastic sheets are indeed recommended and specified for high-quality rigid concrete floors. Figure 1 shows typical details of plastic sheeting for a rigid concrete floor. Similar use of plastic sheeting with flexible segmental paving is detrimental and has the opposite effect to that stated and believed to be beneficial by small paving contractors. Figure 2 shows a typical detail of a flexible segmental pavement where a plastic sheet layer has been specified.

It is clearly inadvisable to specify and use plastic sheeting either under the bedding sand layer or at any other location within a flexible segmental pavement. It is first necessary to evaluate good flexible segmental paving practise and compare this with the undesirable practice of using plastic sheeting in flexible paving. It is a necessary part of the investigation to consider load transfer and flexible pavement intimacy. It will be shown that there are no known benefits for the use of plastic sheeting in flexible paving; indeed the detrimental effects caused by its use reduce both the life and the aesthetics of the



Plastic sheeting used under rigid pavements

FIGURE 1



Plastic sheeting used in flexible paving

FIGURE 2

pavement.

THE USE OF PLASTIC SHEETS IN RIGID PAVEMENTS

In the best practice of rigid pavement design and construction plastic sheets are specified as an essential part of the system. Indeed various bodies which teach and give guidelines on good practise, such as the South African Portland Cement Institute (PCT), recommend their use. (1) Plastic Sheeting is specified and used for a variety of reasons including the need to stop capillary attraction of ground water through the slab. Water drawn up through concrete slabs can cause damage to surface finished.

In rigid paving, care must be exercised to ensure that the sheeting is wrapped around the ends of the slab to protect it completely from moisture ingress. Proper and adequate overlapping of adjacent sheets is obviously also necessary to protect from the effects of moisture. Similar examples of careful wrapping and lapping of plastic sheeting with flexible segmental paving can be cited! The use of plastic sheeting with rigid slabs provides a shear plane under the slab, necessary for attenuation, thermal, warping and other movements where slabs overlay rigid or stabilised sub-layers. This employs the principle of bonds breaking and is the opposite to what is desirable in a flexible segmental paving System.

PLASTIC SHEETS USED WITH FLEXIBLE PAVING

Builders and artisans who become pavers, in attempting to provide the best service to their customer, offer to replicate good rigid concrete slab practises. They do not realise that the design principles for each system are different. In their desire to give the best service, by using plastic sheeting they are reducing the life of the pavement.

Flexibly designed segmental pavements comprise a system where each of the components have a different but integrated function. Each of the elements play an individual role in association with the other parts of the system. The blocks themselves are rigid but collectively form a flexible pavement. The correct specification and use of un-cemented bedding and jointing sand is needed to transmit forces within the system. Correctly specified, sands used in a flexible paving system provides resilient under design loads. Figure 3 shows the various elements of a flexible paving system, all of which must be structurally intimate.

BASIC FLEXIBLE DESIGN PRINCIPLES

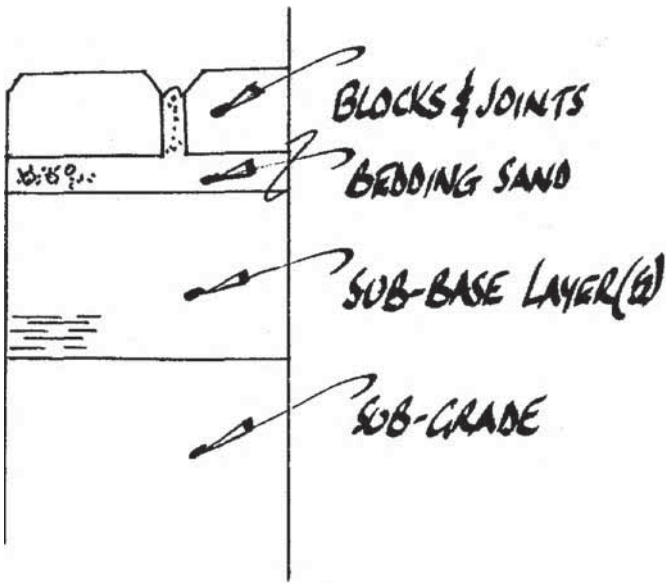
Segmental paving has rightly been described as "forgiving", because overloading causes permanent deformation and restructuring of the sands without classic failure conditions familiar with rigid pavements. When overloaded rigid small element blocks reposition themselves within the newly established sand matrix. Even if severe permanent deformation has occurred the pavement soon re-establishes itself, sealing its joints and thereby continuing to act as a fully capable structural pavement. (2) In many such cases the carrying capacity of the pavement is actually improved by overloading, because the additional compaction or consolidation of sub-layers caused by overloading allows these layers to support greater loads. Figure 4 shows how a seriously overloaded and therefore permanently deformed segmental pavement re-established itself whilst maintaining structural adequacy.

The regular pattern of the relatively small joints in segmental block paving provided each block with the means to transmit loads both laterally and vertically to other elements within the system. Each joint functions as a construction, expansion and contraction joint. Joints also serve to waterproof the pavement from the ingress of large amounts of water. Figure 5 shows the purposes served by the joints and indicates how they respond to various applied stresses.

Because there is a certain desirable permeability in a flexible paving system, needed for resilient response particularly to thermal movements, the joints are not intended to be fully waterproof. Only partial isolation of the other elements of the paving from environmental changes is therefore achieved. Until recently the full benefit of this was not appreciated. In times of light rain and with sporadic showers, segmental pavements have a desirable but minimal absorption factor which reduces run-off.

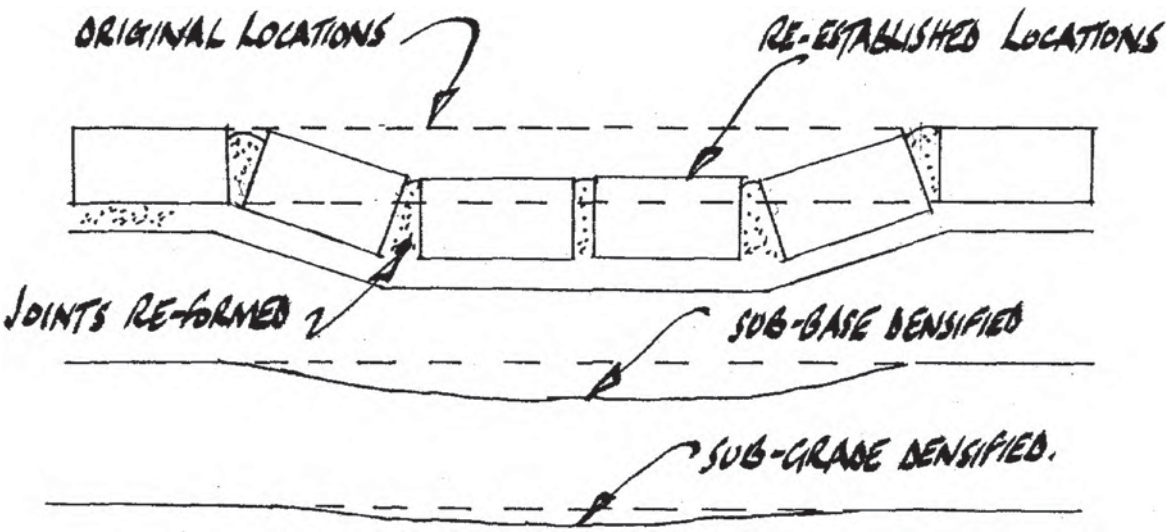
The joints also serve as load transfer devices from one block to its neighbour. Loads applied directly on top of a single block are therefore laterally transmitted in part to the surrounding blocks. Figure 6 shows lateral and vertical dissipation of stresses due to applied loads.

Because of the various functional needs discussed above all the elements of a flexible segmental pavement system must be structurally intimate to achieve optimal effectiveness. Stress dissipation should be throughout the system but within the limits of each structural layer or member. The bedding sand is itself a structural layer and must not therefore be used to correct poor surface levels to the sub-base upon which it stands. Varying the thickness of bedding sand at various parts of the pavement soon reflects into undesirable differential surface levels.



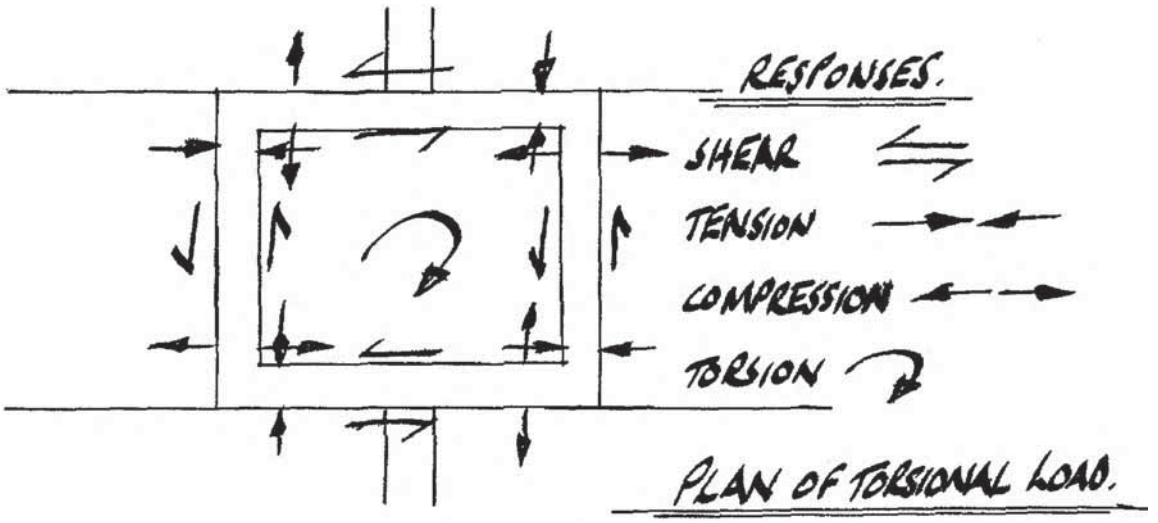
Typical flexible paving system

FIGURE 3



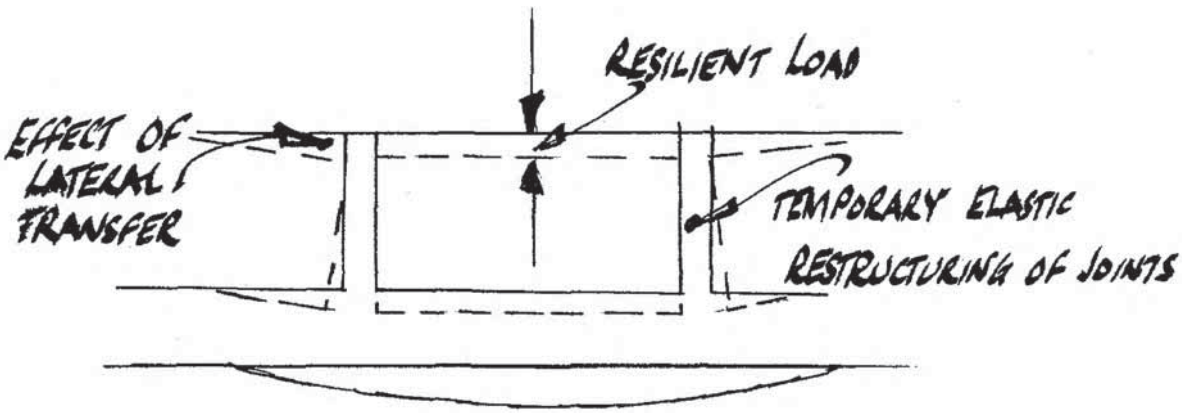
Re-established distressed flexible pavement

FIGURE 4



Joints and stress transfer

FIGURE 5



Lateral load transfer

FIGURE 6

In some respects the response of flexible segmental block paving systems can be described as "a living system". Micro-movements under resilient loading and from seasonal environmental loading are respond to in an elastic manner within the pavement.

WEEDS GROW IN THE JOINTS

It is often stated that the principle reason for the provision of plastic sheeting in segmental paving is to stop weeds growing in the support layers. This misguided and incorrect thesis can be countered simply. If a brick were left on a lawn the grass soon discolours and dies. By paving directly on top of vegetation similar rapid death of weeds and other plants takes place. Simple observation will confirm that subsequent growth of grass or weeds in paving takes place in the joints between the blocks. Roots of trees if not removed might continue to grow under paving and the use of plastic sheeting will do nothing to stop such growth.

A trafficked pavement does not have volunteer weed and grass growth because the action of passing traffic does not allow sufficient time for seeds to lie on the bedding sand and germinate. Seeds are either sucked out of the joints by passing vehicles and they are compacted into the joints. Seeds lying on the upper surface of blocks are soon squashed by tyre pressure and will not usually germinate thereafter.

In many domestic paving specifications it is good practise to require weakly cemented jointing sand in the top one third of the joints to arrest weed growth. Cemented material is either swept in wet or dry, after the initial plate vibration compaction. When the dry procedure is used the cement in the mixture soon satisfies its demand for moisture from adjacent blocks. On hardening the upper part of the joint is substantially protected from subsequent weed growth. The relatively light loads and trafficking of domestic paving allows this change from established industrial segmental paving practice, where no cementing material is used.

DETRIMENTAL EFFECTS OF THE USE OF PLASTIC SHEETING

Plastic sheets used at any location within a segmental block paving causes loss of bond and intimacy between the various parts of the paving system. A shear plane is readily provided effectively separating the upper part of the paving from the lower part of the system. This is particularly problematic when there is torsional loading or on slopes. Indeed on slopes the

pavement can readily buckle with the loss of bond between the paving blocks with the bedding layer.

The use of plastic sheeting causes water draining through the joints to be parched and saturation of the bedding sand occurs. This is undesirable as saturated material offers less resilience to transmitted loads. Some drainage of moisture through the joints is environmentally desirable as run-off is less. In shower conditions or when intermittent storms occur, the absorption factor of the porous blocks and the jointing sand is beneficial to drainage design since run-off is reduced. The use of plastic sheeting also causes water to raise vertically within the pavement and it is arrested below the sheeting. This usually causes deteriorating bearing capacity in the sub-base and is responsible for rapid loss of pavement carrying characteristics.

All the above conditions provide an undesirable shear plane with loss of intimacy in the pavement as a system. Saturation of bedding sand can cause the differential movement of blocks under applied load. Edges of the blocks move more than the centre of the block causing rocking and subsequent pumping of fines through the joints. Rocking blocks inevitably soon cause punching where corners are forced through plastic sheeting. This in turn causes differential saturation conditions in the lower layers of the pavement with associated differential carrying capacity. This situation has proved a major factor in aesthetic depreciation of domestic pavements.

Plastic sheeting is an expensive "optional extra" where initial costs are minimal by comparison with the costs of long term effects on the pavement. Such longer term effects are usually only apparent after the period of maintenance warranty has expired.

CONCLUSIONS

There is clearly a need to provide the many sincere yet under-educated paving contractors and their clients with the principles relating to flexible segmental paving. A results of this would achieve greater credibility for the paving industry and the unique benefits of flexible small element paving will the better be realised. Good construction practices for rigid pavement design as has been shown do not directly translate into good practise for flexible paving. In many cases a direct translation of good practise from rigid to flexible paving are of negative value.

To offer a solution to the above "THE PAVING INSTITUTE" has been founded in southern Africa. It is an independent professional consultancy serving the needs of specifiers, manufacturers and pavers. It provides training and arbitration in disputes and

seeks to set standards for the paving industry from the "bottom up", by teaching and ensuring good practise based on both empirical and theoretical knowledge. This paper therefore in part seeks to supplement the educational arm of "THE PAVING INSTITUTE".

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