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THE CASE FOR OR AGAINST NIBS ON SEGMENTAL BLOCKS

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SUMMARY

The use of nibs on segmental blocks is increasing as users recognise the importance of an adequate structural joint between individual units. Nibs are small protrusions formed on vertical faces of blocks during their manufacture so that units cannot be laid without a minimum space for a joint between them. Nibs were developed, and are particularly important, for the mechanised laying of units.

In the developing regions of the world like the southern African region, most block laying is done by hand. It is still the practise of some pavers to use rubber hammers when placing blocks to reduce joints to an absolute minimum. It is a fact which is now all too obvious that tight joints are responsible for corner spalling and the ingress of moisture into the paving system, both with detrimental effects.

This paper sets out an argument for, and a counter argument against, the use of nibs on segmental blocks for the provision of a minimum joint around each block. There are disadvantages of the use of nibs and the author has discovered that many in the paving industry are unaware of any disadvantages.

The paper further discusses the merits and the demerits of the points raised for both hand-laying methods of paving and for mechanised-laying of paving. Conclusions from the discussions presented are reached and a recommendation for the universal use of nibs is made.

THE ARGUMENT FOR OR AGAINST NIBS

This paper establishes an introductory argument concerning nibs by analysing the purposes of sand joints within the matrix of the flexible segmental block paving system. These findings are used

to evaluate the advantages and benefits, or the disadvantages and limitations of the use of nibs. Because nibs ensure at last a minimum joint conclusions will be reached to justify the use of nibs if they are properly located on blocks. Proper location is considered with particular reference to the effect of nibs on adjacent blocks as laid in all the varieties of patterns possible with the shape of the unit in question. However it will be stressed that knowledge of the limitations of the use of nibs needs to become common knowledge.

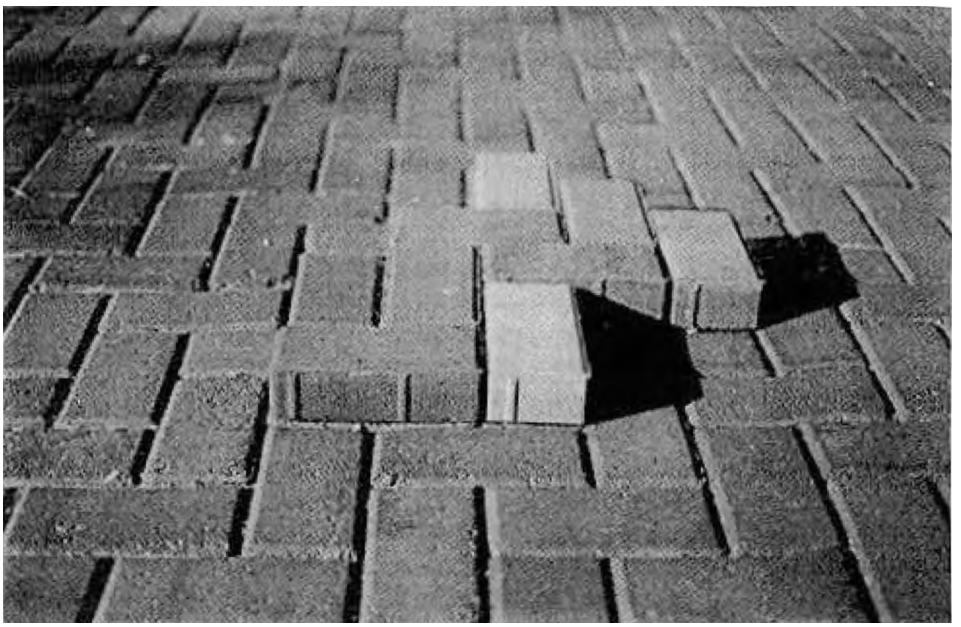
EFFECTIVE JOINTS ARE ESSENTIAL

Most specifiers and paving contractors now recognise that it is essential to have effective joints around individual blocks on every segmental paving job, whether the paving is load bearing or not. The joints are perhaps the most important part of the composite segmental paving system, because they provide the desired flexible response under applied load. Most concrete segmental saving units are now manufactured with nibs. These small protrusions formed on vertical faces of blocks during manufacture ensure the provision of at least a minimum joint. Figure 1 shows a typical nibbed block. Nibs were developed for the mechanised laying of units which if used to construct un—nibbed block pavements, especially with the accurate dimensional tolerance achieved by modern block making machines, result in virtually no joint being provided.

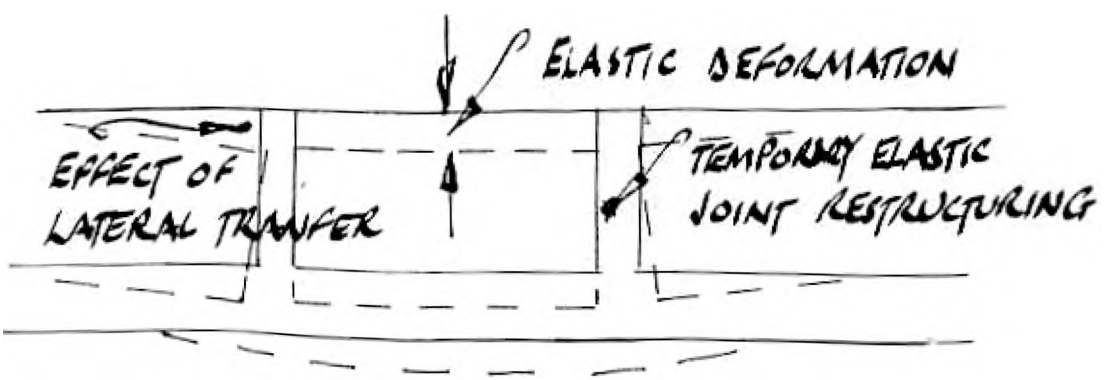
A study of joints and bedding sand was the subject of an intensive South African investigation leading to the author's doctoral thesis on the subject. (1) Ranges of effective joint widths were established in this study together with the optimal material for joint filling. These are critical for effective flexible paving, particularly for the lateral transfer of stress. Torsional and other loads must be transferred laterally through the joints as part of the elastic response of the pavement as a whole under both transient and permanent loading conditions. Figure 2 shows the significance of the joints in stress transfer.

Many problems resulted from lack of our current understanding of the purposes and functions of the joints. It is still unfortunately the practise of some pavers in southern Africa, where most paving is laid by hand, to use rubber hammers to reduce joints to an absolute minimum. This practise used to be encouraged in the misguided belief that a minimum joint width meant that the payement had the greatest amount of rigid concrete sur—facing, and would therefore be able to carry greater loads. Tight joints were also encouraged for what was then considered to be a better aesthetic appearance.

Problems occur in pavements with inadequate joints. If blocks



Photograph of well located nibs on a concrete paving unit.
FIGURE 1



Function of joints and bedding in stress transfer
FIGURE 2

are laid very closely together joints can be almost non existent. Tight joints cannot be filled with Jointing material and allow moisture ingress into the pavement. At the other extreme inef fective joints result from very wide joints since subsequent loss of jointing material leads to moisture ingress.

In some cases the problems of poor performance or poor aesthetic caused by these practises gave the segmental paving industry as whole a bad name. Assuring adequate joints can be readily achieved by design, but any correction of the effects of poorly jointed blocks attempted after construction is almost impossible without taking-up the paving and relaying it properly. Apart from the points discussed the establishment of proper joints is relatively easy means of quality assurance.

Each joint serves the paving system in complex ways. It become not only the construction joint but also serves as the expansion and contraction joints around each individual block. Concrete blocks with nibs ensure a minimum joint width even when units ar tightly butt-jointed.

Nibs are of particular importance where mechanical laying techniques are used as the laying machines compress packs of block during the laying process. Without nibs, and with the manufacturing ability of very accurate dimensional tolerances now typical of modern manuf acturi.ng techniques, mechanical laying can eliminate joints almost totally.

Problems experienced in paving where joints are too tight include spalling of corners caused by adjacent blocks touching under the application of load. In this condition lateral transfer of stress takes place directly from one unit to its neighbour. Impact and other forces soon.initiate progressiva spalling. Physical contact causing rapid and progressive spalling also result in the rapid demise of pavement aesthetics.

However, even in a considerably spalled pavement there is often no loss of structural capacity providing the joints have not allowed the ingress of considerable amounts of water into moisture susceptible sub-layers. Spalled corners may cause the uninitiated owner of the paved facility to rate his entire pavement to have failed, simply because of its aesthetic appearance.

STRESS ENVIRONMENT

Loads and their associated effects on segmental paving result not only from both static and transient loading conditions, but also from environmentally induced effects. For this reason the arguments regarding nibs are valid for the non—loaded use of block such as the protection of embankments. Temperature differential

between summer and winter climatic conditions can be dramatic especially in some continental land masses. If the pavement was laid in the coldest time of the year for example, tightly jointed concrete units would be at their minimum dimensions. This is not unlikely in inland areas of southern Africa where block laying is a year round activity as sub-zero temperatures last for only a short period each year. Subsequent increases in ambient temperature in the summer cause expansion of the blocks.

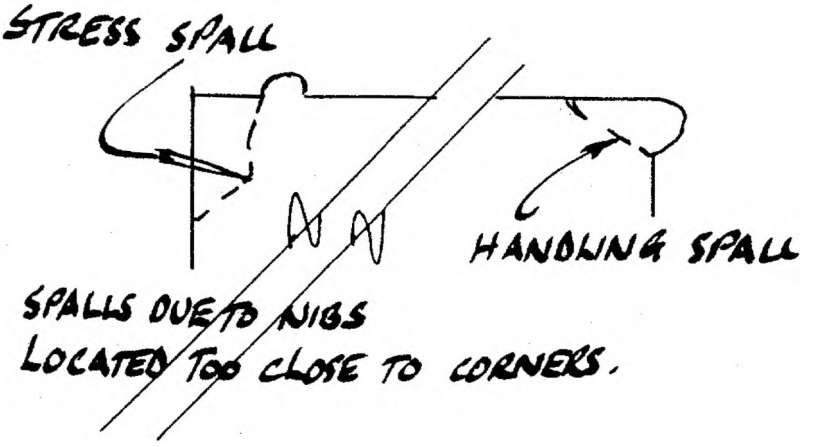
Physical contact of adjacent units through their nibs cause significant point loads inducing additional localised stress. In some units manufactured with poor location of nibs this additional point-loaded stress has caused spalling under environmental conditions only. Figure 3 shows the potential for distress with poorly located nibs. Under applied loading and especially where torsional loads occur rapid deterioration could be expected as a result of poorly located nibs.

Joints further serve substantially to seal the. pavement from the ingress of water. With the particular type of cohesive sand specified for joints, sealing is effected by the material expanding slightly from its dry state condition thereby causing a degree of pressurisation within the joints. Lateral pressures exerted on adjacent blocks help maintain pavement intimacy and assist in load-transfer as well as in waterproofing the pavement. Evidence of the stresses built up in joints by the cohesive material used can be seen when "unzipping" a pavement to install a pipe or to make a repair for example. Unless the opening is braced apart there will be gradual creep of the units because of relief of pressure in the joints. Subsequent reinstatement of the original blocks where bracing was not done is almost impossible without cutting.

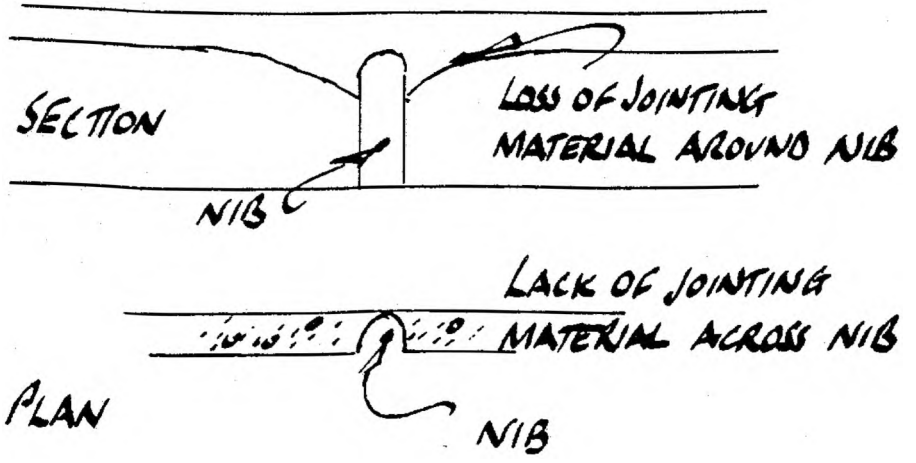
Where nibs are used, some loss of intimacy in the joint results because of the reduced section of jointing material in the location of the nibs. Figure 4 shows the areas of some loss of joint intimacy with nibs.

□DINTS IN THE COMPOSITE PAVING SYSTEM

Segmental block pavements are a complex system requiring each party of the system to fulfil its unique role. The upper pavement layer is complex in itself as it is formed by the blocks and their jointing and bedding sand. Although it comprises substantially the rigid components of the blocks themselves, it responds flexibly under loading due to the sand jointing and bedding. In the event of overloading or during loading leading to fatigue in which the limits of the design including the factor of safety are exceeded, the system responds by deforming permanently.



Poorly located nibs showing potential areas of distress
FIGURE 3



Loss o-f intimacy in jointing material around nibs
FIGURE 4

perntanent or non-resilient deformation requires the restructuring of the flexible elements in the paving system.' No changes in section of rigid units obviously can take place if the units are protected with adequate joints and bedding sand. Without this protection permanent deformation could cause spalling and other physical damage to rigid units. One of the reasons for the specification of a cohesive and un-cemented material to be used for jointing is to allow restructuring of joints to take place should overloading and permanent deformation take place.

During the imposition of a seriously damaging load or combination of loads permanent deformation is caused by additional compaction of sub-layers. Long-term static loading or large numbers of resilient loads over a long period of time might cause consolidation of supporting layers. These support layers are integral parts of the flexible segmental paving system and need to be designed accordingly. Loads applied on the surface are known to effect material to some considerable depth, indeed legal road loads are known to affect a pavement structure to a depth of at least two metres below the surface. <2)

Deformations which do occur in sub-layers are reflected in the block paved surfacing which settles to mirror the new levels of its support. There must also be a re-establishment of the jointing and bedding sand and as they are not cemented they have the ability to reform as necessary.

After deformation the paving system soon reforms and settles-in again to become effective in response to both environmental and imposed loading. Load-transfer and joint-sealing soon become features of the block pavement. If the pavement were made of any other type of construction such misuse would cause it to fail structurally. Reinstatement of original levels is,simple and inexpensive, involving removal of the block surfacing layer and making up to existing levels with relatively inexpensive sub-layer material. Reconstruction of the surface involves using the same segmental units which were taken up.

Segmental block pavements are known as "forgiving" because of their ability to reform under overloaded conditions and because of their ability to continue to serve the structural needs thereafter. It must not be forgotten that this is due substantially to the function of the joints in the pavement. Often overloading helps the pavement to carry greater loads because the additional compaction of the sub-layers caused by the overloading allows such materials to carry greater loads. Reinstatement to the surface might thereafter allow a load-damaged pavement to be used in a higher capacity of loading. Whereas rigid pavements crack and rapidly loose serviceability, flexible block pavements often improve with overloading.

The rapid resealing of the joints which takes place naturally

after permanent deformation, causes them to serve again as contraction and expansion joints and to provide joint sealing.

CONCLUSIONS

The case for the use of nibs on blocks was initially justified by the increasing use of mechanical laying methods. Mechanical laying methods currently in use of necessity compact groups of blocks together during the laying process. Nibs are therefore needed to provide joints. In developing countries, where hand laying is the norm, there is still the wrong belief that smaller joints give a stronger pavement. The use of nibbed blocks ensures a joint in all laying conditions.

In many parts of the world including southern Africa, job creation projects include the upgrading of streets employing out-of-work unskilled people to pave the streets with blocks. Limited competent supervision is normal but the use of nibbed blocks for such projects does much to ensure functional standards.

The case against the use of nibs on blocks is that where the location of the nibs is poor there is the likelihood of damage due to spalling under load. With proper design there should be no cause for spalling or shearing of units under load. In one case seen by the author the forces induced by thermal expansior and applied load caused the units to break in half.

Another argument against the use of nibs on blocks is that there is no control on the maximum width of joints attained. Even witl reputable pavers wide joints can occur especially when a particular method of adjusting long lines is done before the jointing procedure takes placd. Excessive joint widths can sometimes result from, attempting to maintain lines when paving around corners, a practise which can cause loss of structural capacity.

In this method the pavers prise individual blocks to their final position as determined by eye. Some pavers who practise this have told the author that they deliberately leave wider joints than others to allow for this practise. One such team calculatec that the wider joints they used were saving them money on larget jobs since they would not need to provide as many blocks. This method is valid for use with blocks without nibs as the finishec joint width for the pavement as a whole is around the mean. All joints would typically be within acceptable and specified range.

It would seem that the verdict demanded of the evidence.submitter in this paper supports the case for the use of nibs on blocks. There are times when the use of nibs is not the best but the evidence for their use far outweighs the evidence to the contrary. Even in the developing parts of the world where hand

laying methods are the norm, the case for nibs on blocks has been proved.

Because the benefits of nibs on blocks outweigh the disadvantages, it can be expected that even in regions like southern Africa where most laying will be by hand methods for the foreseeable future, the manufacture of blocks with nibs will soon become the universal practice.

It must now be hoped that the poor understanding in the past of the need to provide effective joints which has left a limited legacy of poorly performing pavements, will be relegated to history. With the introduction of nibs on blocks there is no reason why proper joints, essential to effective flexible segmental block paving, cannot be provided.

BIBLIOGRAPHY

1. CLIFFORD, J M. "Some aspects of the structural design of segment al block pavements in southern Africa". Doctoral thesis submitted to The University of Pretoria, 1984.

2. FREEME, C R, MAREE. J H, VILJOEN, A W. "Mechanistic design of asphalt pavements and verification using the heavy vehicle simulator". Proc. Sth Int. Conf, on the Structural Design of Asphalt Pavements Vol.1. Delft Netherlands, 1982

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