SPECIFICATIONS FOR SEGMENTAL CONCRETE BLOCK PAVING IN THE REPUBLIC OF SOUTH AFRICA

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SUMMARY

The successful use of segmental concrete block paving depends in part on specifications which outline the materials and standards of workmanship required. These specifications must be based on sound practice but must be continually reviewed in the light of new experience and developments.

In this paper the main features of current specifications of the Concrete Masonry Association and projected national documents are outlined. Areas of concern, such as permissible materials, shape and appearance of blocks, block strength, laying patterns and joint widths, bedding and jointing sand and surface tolerances are discussed.

INTRODUCTION

Segmental concrete block paving was first introduced into South Africa some 16 years ago and annual production is at present approximately 3 million square metres. National standards on quality of production and use have so far not been promulgated. In 1981 the Concrete Masonry Association published its own "Specification"[1] as an interim measure to set appropriate standards for paving blocks. CMA members are required to comply with the Specification. Compliance is monitored through independent sampling and testing of production at regular intervals. The Association has also published two further documents entitled "Guidelines"[2] and "Laying Manual"[3] to assist consulting engineers, designers, specifiers and contractors with information on the design and construction of segmented pavements.

A South African Bureau of Standards specification on "Precast concrete paving blocks" is due for publication in 1984.

A standardised specification on "Segmented paving" is also in the final stages of production. It covers paving constructed with precast concrete blocks. These standardized specifications are intended for civil engineering construction and are acceptable to clients, engineers, and contractors. Their prime purpose is to achieve standard and unambiguous documents which produce savings through lower contract prices, reduction of time spent in the administration of contracts; and establishment of adequate but practical standards of workmanship and administrative control. This SABS document is associated with the appropriate code of practice which covers the format and content of project specification together with schedules of quantities required for contract documents.

Terms used in this paper are defined in Appendix A.

THE CMA SPECIFICATION FOR PAVING UNITS[1]

Materials

Cement Ordinary portland cement, rapid-hardening or a blend of milled granulated blastfurnace slag with ordinary portland cement are permitted. Pulverised fuel ash may also be used either as an aggregate or to replace cement, thus permitting a reduction in costs and facilitating manufacture.

Aggregates Natural aggregates complying with SABS 1083[4] are permitted. However, artificial aggregates, such as slag, may be used provided they comply with the same requirements as for natural aggregates.

To ensure satisfactory skid resistance, the maximum quantity of acid-soluble material in the fine aggregate (minus 4,75 mm material) is limited to 25 % in both the fraction retained on and the fraction passing the 0,6 mm sieve.

Admixtures and pigments

The benefits of chemical admixtures as accelerators, water reducers, extrusion aids, water repellants, etc., are recognised and thus permitted.

Pigments are required to be in accordance with BS 1014.[5] Pigmentation may be partial, i.e. confined to the top surface, or the block may be pigmented throughout.

Physical properties of paving block

Shape

The top edges of the wearing surfaces of blocks may be chamfered. Chamfering should not however reduce the gross area by more than 30 %.

As research at the National Institute for Transport and Road Research, Pretoria, and local experience indicate that shape plays an important part in the performance of a segmented pavement in service, the CMA specification considers three basic shapes. In order of structural performance these are:

(a) Type S-A, which provides geometrical interlock on all vertical faces and permits block laying in a herringbone bond pattern.

(b) Type S-B, which provides geometrical interlock on some vertical faces only and units may not necessarily be laid in a herringbone bond pattern.

(c) Type S-C, which provides no geometrical interlock, e.g. rectangular units.

Measurements of joint width in local pavements have shown that the average width of joint and variation in width in S-A blocks are significantly less than in pavements containing S-C (rectangular) blocks.

Appearance

As the definition of surface defects, and tests for their measurement, are contentious issues, the Specification requires only that the blocks as supplied should be free from cracks that would detract from their general appearance. Surface hair-cracks which occur in the process of manufacture are not considered to influence performance and durability adversely. A further requirement is that at the point of manufacture blocks should not have chips exceeding 15 mm in maximum dimension and covering more than 3 % of the periphery of the intended exposed surface. It is accepted that good quality paving blocks may be chipped or slightly damaged during handling without this being detrimental to performance.

Excrescences are limited to 3 mm in height.

The surface texture and colour of units are required to fall within the range represented by the manufacturer's approved samples. The coloured layer is expected to be at least 5 mm thick and to form an integral bond with the body of the unit.

Block strength

The strength of blocks is defined as the compressive strength of blocks soaked in water for at least 24 hours and tested between 3 mm sheets of plyboard. The strength is based on the wearing area of the block, i.e. the area enclosed within chamfers. No adjustment is made to the strengths obtained to account for block thickness. As tests carried out at the NITRR[6] suggest that the wet compressive strength of blocks within the range 25 to 55 MPa have no effect on the structural performance of segmented pavement, the average compressive strength of 10 blocks is required to exceed 25 MPa with no block falling below 20 MPa. It should be noted that South Africa has a mild climate and that freezing and thawing do not present a problem.

Paving laying contractors have noted that with high strength blocks (+ 40 MPa), a small but significant amount of spalling and edge chipping can occur during compaction and adjustment to line of these blocks, suggesting greater brittleness.

THE CMA SPECIFICATION FOR LAYING OF SEGMENTAL PRECAST CONCRETE PAVING BLOCKS[3]

Laying pattern and edge restraint

As it is recognised that segmented paving performs best when the units are laid in a herringbone pattern, this pattern is generally required in South Africa. Shaped blocks that cannot be laid in herringbone bond are required to be laid with their axis at right angles to the direction of traffic.

Adequate edge restraint in the form of kerbs and channels, either precast of cast in-situ, to prevent outward migration forms an essential component of block pavements in South Africa.

However, because of the relatively high cost of providing kerbing for narrow, lightly trafficked footpaths, there has been a tendency to omit this lateral support, resulting in migration of blocks, excessively wide joints and the proliferation of weeds.

Bedding sand

Following research by Shackel at the NITRR[7] in 1980 which showed the choice of sand for use in the bedding layer to be a crucial factor in the performance of segmented pavements, the grading limits specified for bedding sand are:

Sieve size (mm)	% passing
9,5	100
4,75	95 - 100
2,36	90 - 100
1,18	50 - 85
0,600	25 - 60
0,300	10 - 30
0,150	5 - 15
0,075	0 - 10

However, a number of sands derived from gold mine milling processes and some dune sands, with gradings falling outside the above limits, have also been found to be satisfactory.

Shackel's research also showed a reduction in the bedding sand thickness from 50 to 30 mm to be beneficial in reducing the deformation of block pavements under traffic. In consequence, the thickness of the compacted sand layer is required to be 25 ± 10 mm.

The importance of maintaining the bedding sand in a uniform condition, i.e. thickness of sand and moisture content and preventing isolated precompaction, is recognised as crucial for the achievement of the surface acceptance tolerances stated in Appendix B.

Block laying

The maximum joint width is limited to 5 mm. Compliance with this maximum joint width has been found to be difficult in cases involving shaped blocks manufactured with different moulds, or blocks made after some mould wear has occurred.

A minimum joint width is not currently specified. Some spalling of rectangular blocks laid to practically zero joint width has been observed during hot weather conditions.

Compaction of blocks

The requirements for mechanical flat plate vibrators used for the compaction of blocks are summarised in Appendix C.

The use of rubber covered plates and other compaction equipment requires further investigation.

Jointing sand

Sands having a maximum size of 1,18 mm and containing 10-50 % material passing the 0,075 mm sieve are required.

Surface tolerances

The achievement of the specified surface tolerances given in Appendix B occasionally result in disputes. Where the main civil engineering contractor constructs the subgrade and subbase and is followed by specialist block laying contractor, these disputes often result from surface tolerances on subgrade/subbase layers which are either not up to standard, or from subgrade/subbase tolerances which are incompatible with those on the finished surface of the block pavement.

The time at which the finished surface is checked for compliance with the specification has also caused disputes. It is the CMA's opinion that the surface be checked before opening to traffic, especially when a specialist paving subcontractor is employed.

CONCLUSION

The successful completion of any paving job is dependent on specifications which are clear and unambiguous on the requirements for standards of material and workmanship. While existing South African specifiations are generally considered to be satisfactory, certain requirements, notably in the area of quality assurance, require investigation.

REFERENCES

1. CONCRETE MASONRY ASSOCIATION. **Precast concrete paving blocks:specification.** 2 ed. Halfway House, The Association, 1983.

2. CONCRETE MASONRY ASSOCIATION. **Precast concrete block paving construction: guidelines.** Halfway House, The Association, 1982.

3. CONCRETE MASONRY ASSOCIATION. **Precast concrete paving blocks: laying manual.** Halfway House, The Association, 1982.

4. SOUTH AFRICAN BUREAU OF STANDARDS. **Standard specification for aggregates from natural sources,** SABS 1083-1976.

5. BRITISH STANDARDS INSTITUTION. **Specification for pigments for portland cement and portland cement products.** BS 1014:1975.

6. NATIONAL INSTITUTE FOR TRANSPORT AND ROAD RESEARCH. **Structural design of segmental block pavements for Southern Africa.** BY J M Clifford, Pretoria, The Institute, 1982.

7. SHACKEL, B. An experimental investigation of the roles of the bedding and jointing sands in the performance of interlocking concrete block pavements subjected to traffic. **Concrete Beton n.19 1980, p5-15.**

APPENDIX A

DEFINITION OF TERMS

Segmented paving: Paving constructed with precast concrete blocks in such a way that units are laid closely together, the joints between them being filled with a fine sand.

The basic components of a segmented pavement are -

(a) a surface course of blocks
(b) a sand bedding course

) termed the base

(c) a subbase (only when warranted by traffic)

(d) the subgrade, and

(e) edge restraint, provided by kerbing.

Block: A unit of such size that it can be laid with one hand, if necessary, normally of approximate length 200 mm; width 100 mm, and thickness 50-120 mm, or 40-50 units/m^2.

Bedding course: A course below the block surface course comprised of fine sand laid to a target compacted thickness of 25 mm.

Subbase: A layer or layers of untreated or treated material of a quality higher than that of the subgrade. Examples of subbase material are: crusher run, cement-treated crusher run or gravel, and materials that have been treated with lime.

Subgrade: The completed earthworks within the road prism prior to the construction of any subbase or sand bedding course.

Edge restraint: Lateral support along the edge of a block pavement to prevent the outward migration of blocks, which would result in the opening of joints.

APPENDIX B

SURFACE TOLERANCES : CMA SPECIFICATION (3)

The finished paving shall be so laid as to create a regular and smooth appearance.

Surface tolerances shall be as follows:

(a) maximum deviation in surface level from the true surface level to be ± 10 mm, except immediately adjacent to gullies, where the tolerance shall be + 3 mm and 0 mm;

(b) maximum deviation from a 3 m straight edge placed on the surface of the pavement to be 10 mm, except where vertical curves necessitate a greater deviation;

(c) levels of adjacent blocks shall not differ by more than 3 mm; and

(d) the line of the pattern shall not deviate more than 15 mm from a 3 m straightedge.

APPENDIX C

COMPACTION OF BLOCKS : CMA SPECIFICATION (3)

After laying the blocks, a mechanical flat plate vibrator shall be applied to the surface of the blocks to bed them. For block thicknesses up to and including 80 mm the vibrator shall be capable of producing a centrifugal force of approximately 7 to 16 kN at a frequency of approximately 75-100 Hz, the plate area being between 0,2 and 0,4 m^2. For greater thicknesses the required centrifugal force shall be 16-20 kN at a frequency of approximately 75-100 Hz, the plate area being between 0,35 and 0,5 m^2.