CURRENT USAGE OF INTERLOCKING PAVING IN AUSTRALIA

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ABSTRACT

This paper summarises the development of the interlocking paving industry in Australia from its inception in the mid-1970s to the present time, when production now exceeds 5 million square metres per annum. The steps taken in developing design and construction guides, including local and overseas research and practice, are briefly summarised. Current usage of interlocking paving in Australia is then summarised. Applications described include heavy duty areas, housing estates, and lightly- and heavily-trafficked roadways. Details of the applications described are given in an Appendix to the paper.

INTRODUCTION

Interlocking concrete paving was introduced to this country just 12 years ago. From that tentative start in Adelaide, a significant - and rapidly growing - manufacturing and construction industry has developed. Today, usage of all types of interlocking and small component concrete paving exceeds 5 million square metres per annum. This is a phenominal achievement, even by the high growth standards achieved in many European countries in the late 1960s and 1970s. It represents a national per capita usage of 0.32 square metres per annum.

However, this figure is somewhat deceptive as it gives little indication of the scale of usage in those cities where the product was initially promoted. For example, in both Adelaide and Canberra current usage is now well in excess of 1 square metre per capita per annum, i.e. comparable to the figures quoted in Germany and Denmark some 30 to 35 years after they commenced production.

RESEARCH

This growth has been stimulated in part by the results of local research. Over the past nine years, Australian researchers have initiated the most extensive studies of full-scale interlocking pavements - both here and with the assistance of NITRR in Pretoria. This work has made a significant contribution to our understanding of how these pavements perform and the critical factors in their construction.

The results of the initial, and quite modest, investigation undertaken by Dr Shackel were first unveiled in this city at a Workshop convened by the Australian Road Research Board (ARRB) in 1978. It is, therefore, most appropriate that the first Australian international workshop on this topic should be under the auspices of the ARRB in Melbourne. The Cement and Concrete Association of Australia (CACA) is very proud to be associated with this workshop and would like to extend its congratulations to ARRB - and particularly Kieran Sharp - for its initiative in attracting to its shores some of the world's most notable authorities on interlocking paving.

Since 1978, there have been three international conferences on interlocking concrete paving: in Johannesburg, Newcastle-Upon-Tyne and Delft. Australian researchers have featured very prominently in the

papers presented at each of these conferences. It is noteworthy that Dr Shackel, in particular, is receiving an increasing number of commissions from overseas and has been engaged to assess a number of overseas product developments in field and laboratory studies undertaken in this country. These researches are continuing, as later papers will indicate, and are leading to some significant changes in the types of pavers being manufactured locally, and the methods of construction - particularly for large-scale heavy duty industrial pavements - to complement the introduction of mechanised techniques for laying pavers in clusters.

DESIGN AND CONSTRUCTION PRACTICE

At the commencement of manufacture in 1974, there was a dearth of information on how interlocking pavement performed and methods for their design and construction. All the local industry could do was echo European practice based on experience and empirical methods of design. Because of differing climatic and road conditions, these resulted in unduly conservative pavement designs when compared to normal Australian practice.

Local efforts received a tremendous boost in 1976 with the publication of a construction guide by the Cement & Concrete Association in England. This was based on the work done by Alan Lilley and John Collins, and it provided one of the first clear-cut and practical guides to construction. It had a significant influence on Australian construction practice. Present practice is still largely based on, and derivative of, those recommendations, and this country owes a significant debt of gratitude to the authors.

At about the same time, John Knapton published his study published his study of stress distribution in a pavement under load. This in turn provided the basis for the CACA's 'Interim Guide to the Design and Construction of Interlocking Sett Pavements', which was published in 1976.

It was to extend this work, by testing full-scale pavements, that CACA and the Concrete Masonry Association of Australia (CMAA) first approached Dr Shackel. His initial work resulted in the second Interim Design and Construction Guides published by CACA in 1978. These were modified, to a minor degree, in 1980 following Dr Shackel's extensive studies in Pretoria. The two resulting technical notes, 'Design of Interlocking Pavements for Road Traffic' and 'Specification for Construction of Trafficked Interlocking Concrete Pavements', have continued in use up to the present day.

These guides were based on the precepts that:

* pavements tend to stiffen with repeated load applications
* well-compacted, high-quality materials must be used for the basecourse to control deformation prior to the pavement stiffening
* complex profile paving units capable of controlling the spread of joints give superior performance
* an increase in unit thickness leads to improved pavement performance
* joint widths must be controlled within reasonable limits
* depth and quality of bedding sand is critical to the control of deformation
* control of joint width and grading of joint filling sand has a marked influence on pavement performance.

Many hundreds of pavements have been built and constructed in accordance with the foregoing design and construction recommendations. With very few exceptions, these pavements have performed most satisfactorily. Where problems have been experienced, these have usually been traceable to one or more of the following.

* inadequate assessment of the subgrade bearing capacity
* unsatisfactory preparation and drainage of the subgrade
* the use of unsuitable materials in the basecourse
* inadequate compaction and/or thickness of the basecourse
* failure to control sand bedding within nominated tolerances
* use of unsuitable bedding
* excessively tight laying
* use of unsuitable joint-filling sands
* poor detailing at edge restraints and road penetrations

Of these, the use of poor-quality or unsuitable materials has been the most common cause of poor performance.

As a decade has now elapsed since the first guides were published, it was deemed prudent to update design and construction recommendations to take advantage of ten years of field experience and the research findings of the last six years. The new guides which have resulted will be the subject of a later paper to this workshop by John Hodgkinson. This review has been undertaken in the context of a revision of the manufacturing specification - which placed particular emphasis on determining suitable criteria to assess abrasion resistance - and concurrently with the construction of the first mechanically-laid pavements at Tomage, N.S.W., and Islington, S.A.

CURRENT USAGE

Initially, most interlocking paving was used for aesthetic reasons: to upgrade streetscapes - primarily footpaths - and pedestrian access. North Adelaide saw the first use of these pavements in roadways, primarily to define blind intersections and pedestrian crossings.

As the results of local research became known and engineering confidence grew, and the ability of these pavements to tolerate a wide range of loading conditions was recognised, their use in major industrial hardstandings overlaying poor bearing-capacity subgrades developed fairly quickly. Notable works have included the Shell Transport Depot in Footscray; the Webb Dock container area in Port Melbourne; Wooldumper's container storage; the Port Adelaide container stacking shed and the Islington railyard in South Australia; and the Dowling Street railyard in Launceston - to name but a few.

There remained, however, considerable timidity towards the use of interlocking pavements in roadworks - despite this being their most notable use overseas, particularly in European cities, Mexico City, New York, Toronto and New Zealand.

The first major road construction using an interlocking pavement was installed in Adelaide, by the S.A. Highways Department, in the 80 km/h traffic-light-controlled Grand Junction Road and Sudholz Road intersection at Gillies Plains. The pavement was installed in a bid to control transverse rutting due to braking and deformation induced by slewing wheel loads, with consequent damage to electro-magnetic loops controlling the traffic lights. The loops were successfully installed in narrow conduits beneath the sand bedding. This pavement is now some four years old and is performing well. The pavement overlays a poor-quality black soil topped with 200 mm of selected crushed dolomite filling. It comprises 80 mm shape type A pavers, laid in herringbone bond, over a 150 mm basecourse of fine-crushed dolomite and a sub-base of 140 mm of quarry rubble.

Other busy intersections in the Adelaide area have since been reconstructed in a similar manner.

One of the most aesthetically pleasing works has been the re-paving of Moseley Square, Glenelg. This includes a traffic roundabout, tram terminus and parking area adjacent to the beachfront. The major work of the recent past has been the re-building of a 2 km section of King William Road, Unley - a notable achievement which will be the subject of a separate paper to this Workshop.

Another notable work has been the re-paving of the William Street Horseshoe Bridge in Perth. This was undertaken whilst maintaining traffic flow, William Street carrying a major proportion of the north-south traffic entering the Perth CBD. The prime intent was to protect the aging bridge structure from water access by the provision of a new membrane which had, in turn, to be protected by a pavement having a suitably shallow depth. Longitudinal in situ concrete edge restraints were constructed to define each traffic lane and to allow each lane to be re-constructed separately. The pavement is not only attractive, but also it is performing very well under heavy traffic.

If there was a reluctance to use interlocking pavements in main roads, there has certainly been no hesitation in using them to cope with the exigencies of bus traffic. One of the first uses was at Circular Quay in Sydney to tie in with updated pedestrian areas and to replace sections of flexible pavement requiring constant maintenance. These sections of interlocking paving have now been traversed by some 1.5 million buses and were in excellent order until damaged by severe storm-flows in 1985. Only one deformed area had been noted, and the cause of that was traced to an excessive depth of sand bedding.

The most recent works have included bus stations on the spoectacular O'Bahn system in Adelaide, the bus-rail interchange at Elizabeth, S.A., and terminals in Wynnum, Queensland, and Hobart, Tasmania.

The most spectacular growth in usage has, however, been in residential street construction and refurbishment. In older streets the objective has generally been to achieve a more aesthetically pleasing streetscape with improved definitiuon and protection of on-street parking bays. Outstanding examples include Reece Avenue in Klemzig, S.A., and Wingfield Avenue in Crawley, W.A. The latter must surely rank as one of the most delightful and aesthetically satisfying residential streetscapes yet achieved in this country.

In subdivisional work, the objective behind the use of interlocking paving has invariably been to 'lift' the image of an estate, at modest cost. Almost without exception, this has proved a cost-effective exercise. The first of these endeavours was undertaken by the Housing Commission in N.S.W. some ten years ago. The experiment was repeated successfully in a number of similar estates. Perth City Council was also a pioneer and was quickly followed by private developments in the other suburbs. Each of these estates won tangible public approval in the form of uograded land prices and high-quality 'up-market' house construction. One notable estate is Cockburn Waters in Coogee, W.A., where the road system has been effectively colour-co-ordinated to define through routes.

There are also excellent examples in Victoria and on the Gold Coast in Queensland. The most innovative, however, is the latest section of the Karana Downs Estate near Ipswich, Queensland. Here, the developer and the designer attempted to transform the traditional concept of a residential street by introducing abstract colour patterns in the pavement. The effect is both startling and intriguing.

It suggests that the real potential of interlocking paving to transform and create visual delight in our urban environment is only just beginning to be realised.

Details of a selection of the foregoing pavements are listed in the Appendix to this paper.



C.F. 'Paul' Morrish was born in the U.K. and migrated to Australia in 1948. He was Senior Engineer with the Victorian Health Commission between 1950 and 1955 and in private practice as Senior Partner in Morrish, Nelson & Vaughan, engineers and architects, between 1955 and 1964. Between 1964 and 1967, Mr Morrish was Regional Engineer for the W.A. Branch of the Cement and Concrete Association of Australia (CACA). Since 1967, he has been Chief of the Information Division of CACA. Mr Morrish is the author of numerous papers on control of concrete surface finishes, pedestrianisation of shopping centres, and the design and use of interlocking concrete pavements (published in Australia and overseas), including papers to each of the international conferences on interlocking paving.

APPENDIX

SOME TYPICAL APPLICATIONS OF INTERLOCKING PAVEMENTS IN AUSTRALIA

1. TOMAGO ALUMINIUM SMELTER, N.S.W. - Ingot Standing Area

Built 1984. Condition - excellent.

Sand subgrade: design CBR 10%
Design axle load (forklift): 11.5 t
Basecourse: 150 mm cement-treated fine crushed rock (CTFCR)
Bedding sand: 25 mm
Paving: 80 mm 'Anchorlok' - mechanically laid

2. ISLINGTON RAILYARD (STAGE 2), S.A. - Container Transhipment Road/Rail Transfer

Completed 1986.

Clay subgrade: design CBR 6%
Design loads:
small forklifts: 28 t axle loads
transtainers: 42 t wheel load
major forklifts: 60 t - front axle

General Areas:

	Light Forklifts & On-Road Traffic	Heavily-Laden Areas
Basecourse:	230 mm CTFCR	445-480 CTFCR
Bedding sand:	25 mm	25 mm
Paving:	80 mm 'Anchorlok' mechanically laid	80 mm 'Anchorlok' mechanically laid

3. KING WILLIAM ROAD, UNLEY, S.A. - Urban Arterial

Built 1985-86. Condition - excellent. Riding quality - reasonable.

Clay subgrade: design CBR 2%
Sub-base: 150 mm lean mix concrete
Basecourse: 125 mm quarry rubble under 150 mm FCR
Bedding sand: 20-30 mm
Paving: 80 mm shape type A - herringbone bond

4. O'BAHN-DARLEY ROAD BUS STATION, S.A.

Built 1985. Condition - excellent.

Subgrade: design CBR 1%
Axle loads: 10 t
Basecourse: 225 mm CTFCR
Bedding sand: 25 mm
Paving: 80 mm shape type A - herringbone bond

5. N.S.W. HOUSING COMMISSION, CAMPBELLTOWN - Residential Street

Built 1976. Condition - excellent.

Clay subgrade: design CBR 5%
Basecourse: 150 mm FCR
Bedding sand: 50 mm (loose)
Paving: 80 mm shape type A - herringbone bond

6. COCKBURN WATERS ESTATE, W.A. - Residential Streets

Built 1984-86. Condition excellent.

Sand subgrade: design CBR 10%

	Minor Streets	Through Streets
Basecourse:	75 mm crushed limestone	150 mm crushed limestone
Bedding sand:	30 mm	30 mm
Paving:	60 mm shape type A, herringbone bond	80 mm shape type A, herringbone bond

7. KARANA DOWNS ESTATE, QUEENSLAND - Residential Streets

Built 1984-86

Clay subgrade: design CBR 5%

	Early Stages	Later Stages & Minor Streets
Basecourse:	150 mm FCR	150 mm FCR
Bedding sand:	30 mm	30 mm
Paving:	80 mm shape type A herringbone bond	60 mm shape type B/C