EXPERIENCE WITH INTERLOCKING CONCRETE PAVEMENTS: KARANA DOWNS ESTATE, QUEENSLAND

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ABSTRACT

This paper discusses the development of two stages of the Karana Downs housing estate in Queensland which featured interlocking concrete pavers in the roadways, driveways, footpaths and parking areas. The design philosophy adopted, and the steps taken to gain Council approval, are described, together with the construction procedure. The use of pavers of varying shape, colour and thickness - in order to better blend in with the local environment - is highlighted. Some problems encountered after construction of one of the stages, and remedial actions taken, are described. It is concluded that Councils will be receptive to new ideas, provided that they have cause to be confident in new proposals, both from the point of view of adequate supporting documentation and a history of successful use in similar applications. One problem facing the industry is that if paving manufacturers are absorbed by larger companies then there may be problems in meeting future maintenance demands if the range of products originally produced is discontinued or reduced.

INTRODUCTION

"Councils are completely inflexible; they always work to the rule book; they never see it from our point of view; we are never able to try anything new."

How often in the past have we heard developers muttering these words in desperation and frustration following submissions to Councils?

However, with a few Councils, there appears to be a wind of change. Some Councils, it would seem, are now prepared to stick their neck out in the interests of progress and on occasions put the rule book to one side.

My experience over the last few years with a very large residential development in South-East Queensland is such a case. It is of interest to note that the times when the developer required Council's maximum co-operation and willingness to venture involved the use of interlocking concrete paving units.

This paper discusses the development of two significant stages of Karana Downs Estate, Queensland, utilising interlocking concrete paving units and poses a question for the concrete paving industry at large.

KARANA DOWNS

Karans Downs is a 660 ha estate situated approximately 30 minutes by road west of Brisbane on the outer fringes of the western suburbs. It is still considered by many as 'bush' country. Its location and environment can only be described as magnificent, being bounded on much of its perimeter by the upper reaches of the beautiful Brisbane River.

The estate is of mixed development, consisting of approximately 400 rural and 900 residential allotments; the rural allotments being confined to the steeper and heavily-timbered areas and the residential allotments to the gently undulating areas adjacent to

the river. In 1974 much of the lower-lying areas were inundated by the great flood, and regardless of the mitigating works carried out upstream, Council still limits development to those areas above the 1974 flood level.

The benefits of these restrictions on the development have been many. Large areas have now been developed to provide alternative amenities such as riverside parks, pony trails, sports ovals and an 18-hole championship golf course and country club. It is these amenities, particularly the river and the golf course, which have given the developer the opportunity to provide real estate which is very much a cut above the average. It is two such opportunities that form the basis of this paper.

By 1981, much of the perimeter of the golf course had been developed to provide both acerage and residential allotments. However, three stages remained: Stages 4, 10 and 17. All three stages were of similar character and importance to the Estate in that they were all situated on high peninsulas extending well out into the golf course. Each stage would provide all allotments with golf course frontage and magnificent views. They were to be treated as `special'.

During 1981, the developer decided to proceed with the first of these stages, Stage 4.

STAGE 4

Stage 4 was to provide 15 allotments, each with an area of approximately 1500 square metres and a road frontage of 35 m. Our consultant's brief for the roadway was to develop something `different' and `up market'.

COUNCIL STANDARDS

Council's standard subdivision requirements for such a development were:

* road reserve width: 16 m;
* carriageway width: 8 m;
* in situ concrete kerb and channel;
* 25 mm AC surfacing;
* unbound granular sub-base; and
* carriageway centreline coincident with centreline of road reserve.

DESIGN

Our design philosophy for such roads is very much that the vehicle is the intruder, and that road widths should be kept to a minimum and maximise footpath widths; the road alignment should prevent high speeds and the road surface should complement the environment rather than be intrusive.

In order to achieve these objectives for the stage, the following standards were proposed:

* increase road reserve width to 20 m;
* reduce carriageway width to 5 m;
* paving units laid on edge to form kerb and channel;
* interlocking concrete paving units for pavement surface;
* the carriageway centreline to meander within the road reserve, reducing speeds and providing a variable width of footpath for landscaping and planting;
* strategically-loacted paved parking areas on footpaths; and
* paved entrance drives to allotments to be provided at the time of road construction.

Having come up with the ideas, there was still one major hurdle to overcome, i.e. Council. Not being a private or group title style development, the road reserve would be taken over by Council at the end of the maintenance period. Little of the proposed standards complied with Council's existing by-laws and engineering standards. It was therefore essential to bring Council `on-side'.

To achieve this, Council members and their technical officers were invited to a presentation by the developer, the paving manufacturer, the consultant, and the landscape architect; this was followed up by a design document and specification for the proposed works (Evans 1981).

At that time, the design of interlocking concrete pavements was based on the then current Cement and Concrete Association of Australia's (CACA) Technical Notes TN34 and TN35 (Hodgkinson and Morrish 1980; Hodgkinson 1980). A cul-de-sac with a catchment of 15 allotments would be included in traffic classification A or B of Table 1 of TN34 and would require the minimum of construction. However, in order to minimise the risk of permanent damage during the early

stages of development when the developer's and builder's concrete and supply trucks would be using the pavement, it was considered prudent to adopt traffic classification D.

With traffic classification D, the pavement was to consist of 80 mm type A paving units of strength Grade 45 MPa laid in a herringbone pattern on a sand bedding of 30 mm compacted thickness overlying a compacted sub-base. The minimum thickness of sub-base was determined in accordance with Fig. 4 of TN34 as 150 mm.

Drainage and services were to be located conventionally for this type of development; however, SEQEB, after considering the easier access to underground cables with paving units, chose a simplified cable alignment running beneath sections of the carriageway.

Following the presentation and submission of the design document, the above proposals were duly accepted by Council with the following proviso: the minimum road width was to be 5.5 m instead of 5 m and car parking spaces were to be provided at the rate of one per allotment.

During the detailed design stage, the paving supplier expressed reservations regarding the construction of the kerb and channel using paving units laid on edge; therefore this detail was changed to the conventional in situ concrete kerb and channel complying with Council's standard profile.

In order to achieve the aesthetic objectives of reducing the visual intrusion of the paved surfaces and enhance the natural theme of the estate, special consideration was given to block colour. After experimentation by the block manufacturer, blocks with mixed colours of charcoal and dark buff were chosen, this combination being considered to complement the natural colours and shadows of the area. To take this point further, the harshness of the in situ concrete kerb and channel was to be reduced by colouring with oxide additives at the time of construction.

CONSTRUCTION

Construction was carried out under two contracts. After an initial approach to the main contractor for the supply and lay of the paving, it was found that considerable savings were to be had by letting this part of the works to the paving supplier as a separate contract.

Construction of Stage 4 was straightforward for this type of works. Following the earthworks stage, CBR values were in excess of 6 per cent and the sub-base thickness was confirmed at 150 mm throughout. All services, the sub-base and kerb and channel were in place prior to the commencement of the paving contract.

Laying of the paving was carried out by one gang of three to four persons and all pavers were laid by hand. Excellent lines, levels and general finishing was achieved throughout. The total area of paving, including car parking spaces and driveways, was approximately 2000 square metres.

Following completion of the stage, two problems were experienced with the paving. Firstly, one area was showing rapid deterioration of the surface and a degree of spalling. Further testing showed that all blocks affected were substantially below strength. These blocks, which were confined to this one area, were subsequently removed and replaced by the contractor at his own expense.

Secondly, on steeper gradients and on the uphill side of obstructions such as gullies, water continued to seep from the paving for extended periods after rain had ceased. This indicated that, although the paving had been correctly sanded, surface water was still percolating through the joints and running through the sand layer. In this instance there appeared to be no structural problems with the pavement and it was only of aesthetic importance. This problem was noted for future designs.

STAGE 17

Approximately one year later, the developer indicated his intention to proceed with Stage 17. This stage was considerably larger than Stage 4 and was to consist of 52 allotments situated around a complex of culs-de-sac, with the majority of allotments having a golf course frontage. Allotments were of a similar size and road frontage to Stage 4.

Our consultant's brief for this stage was to improve on Stage 4 and produce a development that `sizzled'.

COUNCIL STANDARDS

Council's standard requirements were as for Stage 4, with the exception that road widths of 9 m would be required in certain instances.

DESIGN

The design philosophy was the same as for Stage 4:

* minimum road widths;
* speed restricting alignments;
* wider and varying footpaths; and
* road surface to compliment the environment.

In order to achieve these objectives, we went further than Stage 4:

* increase road reserve width to 20 m as before;
* reduce carriageway width to 5.5 m (minimum acceptable to Council);
* consider alternative profile for in situ concrete kerb and channel, i.e. to reduce obtrusiveness;
* interlocking concrete paving units for pavement surface, this time with varying block shapes and distinctive coloured patterns, i.e. to increase the `pedestrian' effect;
* carriageway centreline to meander within the road reserve as before; and
* strategically-located paved parking areas.

This time there was no major hurdle to overcome with Council, who was now willing to experiment with new ideas for this type of development. Council was, however, to consider both stages as experimental and would only consider making any changes to its standards after the `test of time'.

By this time, CACA Technical Notes TN40 and TN41 (Hodgkinson and Morrish 1982; Hodgkinson 1982) were in existence, and for the same reasons as before, it was considered that the pavement design should be in accordance with traffic classification T4 of Table 2 of TN40. This was unacceptable to me because it precluded the use of 60 mm type B and C pavers, which I considered desirable for aesthetic reasons. I believe that, given a suitable foundation, there should be no reason for not using the alternative block shapes, thicknesses and colours which were available.

In July 1984, Dr B. Shackel of the University of New South Wales was commissioned to make recommendations on design procedures specifically for shape types B and C and to provide a materials and construction specification to support these procedures (Shackel 1984). His report presented two sets of design curves, one for an unbound granular sub-base and one for a cement-stabilised sub-base. The methodology used to derive these design curves was based on a mechanistic analysis of the pavement structure.

These curves indicated that with lower CBR values the sub-base thickness would be substantially greater with type B and C blocks than with type A, e.g. for a CBR of 5 per cent 280 mm (B and C), 160 mm (A). However, CBR values in excess of 15 per cent were to be expected and therefore a minimum thickness of 150 mm was still possible.

We now had a range of block shapes and colours at our disposal. The next step was to obtain approval from the developer for the use of distinctive coloured patterns for the pavement. To achieve this, the supplier laid a trial area in their office forecourt. This trial showed that not only were the patterns aesthetically pleasing, but also that laying rates would remain the same. Pattern shapes and colour combinations were then set out on engineering drawings for construction purposes.

A combination of block shapes and colours was also to be used to provide carriageway markings and pedestrian crossings.

Following Stage 4, it was considered that further thought should be given to the design of the kerb and channel. There is a basic Council requirement that the kerb and channel meet certain drainage criteria, i.e. to retain certain storm frequencies within the carriageway. However, with the catchment areas applicable to this project it was possible to consider alternative profiles.

Several trial sections of kerb and channel with varying profiles were constructed on site, one of which was subsequently approved by Council. This offered a much reduced height and width than the Council standard.

Following these trials, the block supplier submitted a proposal to utilise precast concrete kerb stones in matching colour and material to the paving blocks. This proposal was not only cheaper but also met with our objectives with regard to reduced obtrusiveness. This proposal was accepted by the developer and Council.

Council's requirement to provide one vehicle space per allotment was to be achieved

differently to Stage 4. The developer indicated a preference for longitudinal parking rather than the perpendicular system used previously. Strategically-placed parking bays were provided along all roadways with the exception of culs-de-sac. In these cases, angled parking bays were provided within the landscaped islands to the centre of the turning heads.

Drainage and services were located conventionally with the exception that all roads were designed with a single crossfall rather than the normal crowned profile. On predominantly sidelong ground this reduced cut and fill and also kept drainage gullies to the one side. An additional benefit was that it simplified pavement laying.

CONSTRUCTION

As for Stage 4, construction was carried out by two contracts. In this case the supply and lay of the kerb was included in the paving contracts. The paving contract consisted of approximately 7000 square metres of paving and 2000 m of kerbing.

Construction of the pavement worked progressively from the furthest cul-de-sac towards the point of access to the subdivision. The paving supplier and laying sub-contractor was the same as the previous stage and was therefore experienced with the site.

The laying procedure at edge restraints differed substantially to previously. Before, the kerb and channel was already in place and therefore the pavement was `cut in'. In this case, the paving contractor chose to lay the paving first approximately 0.5 to 1 m beyond the required edge of paving and then to cut back using a diamond saw at the same time as placing the concrete bed to the kerb. This was found to be too slow to maintain good progress and an alternative method was sought. It was eventually agreed to permit an area of each block to extend beneath the kerb unit provided an equivalent in situ concrete edge restraint was provided. This procedure substantially eliminated the need for cutting and hence work was brought back onto program.

Shortly after construction of the edge restraint, the kerb units were bed and haunched. The horizontal alignment was marked on the paving and the vertical alignment was controlled by the pavement itself. This procedure resulted in an excellent alignment of the kerb units which was aesthetically very satisfactory.

Although the colour and pattern combinations were fairly complex, laying rates were not adversely affected. However, the complexity of the various horizontal alignments associated with the parking bays did have an adverse affect.

Carriageway markings at intersections and at parking bays were formed by `cutting in' a combination of buff and charcoal rectangular blocks. It was found that the most satisfactory result was achieved by laying the general paving first and then cutting the exact width required with a diamond saw. This method has provided permanent carriageway markings which will be maintenance free.

Following completion of the paving, the whole area was compacted by a minimum of ten passes of a pneumatic-tyred roller having a gross weight of 10 t. The purpose of this was to provide some degree of initial lock-up before the road was opened to construction traffic.

No problems were experienced with this stage with respect to a lack of block strength or seepage at obstructions.

This latter problem was overcome on this stage by providing a `no-fines' concrete drainage block approximately 600 mm deep and 1 m long on all approaches to obstructions. These blocks were cast to the top of the sub-base level and then overlaid with geofabric to prevent infiltration of the bedding sand.

COSTS

It was recognised from the start of development of these two stages that there would be an increase in costs associated with the use of interlocking concrete paving. In the case of both stages this amounted to approximately $1500 per allotment, an amount considered an acceptable penalty in the area of the market that these allotments were to be directed.

In the two years between stages there was no increase in costs for the supply and lay of the paving. In fact, there was a reduction in real terms. There were probably two reasons for this: (a) the extreme competition in the market, and (b) the use of 60 mm blocks in lieu of 80 mm blocks.

CONCLUSIONS

(a) Councils can be receptive to new ideas, given the confidence for the

proposal being presented. This will only be achieved if the matter is responsibly researched and presented.

(b) The success of pavements utilising interlocking concrete paving is very dependent on meticulous attention to detail, and required considerable experience on the part of the designer and contractor.

(c) Interlocking concrete pavements offer designers the opportunity to break away from the traditional `vehicle' oriented surfacings, and put some variety into our too often harsh and hostile environment.

(d) For any of this to take place, Councils have to develop confidence in the product. This will only come about when there is ample evidence that successful pavements are the norm rather than the exception. Unfortunately, there are many current projects which are not seen as a credit to the industry, and it is suggested that they may be doing a considerable amount of harm.

(e) The two areas of pavement described in this paper have now been inhereted by the Local Authority and with them the responsibility of maintenance. This, I believe, raises an important issue for the industry. The pavements described in this paper have utilised a variety of block shapes, thicknesses and colour - all supplied by one manufacturer. This manufacturer has now been taken over. Therefore there may not be any long-term commitment to produce the same range of products. There is no security in the number of suppliers as products vary from manufacturer to manufacturer. Therefore, are Local Authorities inheriting luxury vehicles with no guarantees for spare parts? Who should be keeping the spare parts? One of the major benefits of this form of paving is the ability to make invisible repairs. But what of the future?

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Mr Evans joined the Southern Water Authority, U.K., in 1956 as a trainee engineer before his interest in roads took him to the Kent County Council Highways Department in 1961. From 1961 to 1980 he gained extensive experience in the planning, design and construction of major highway projects between London and the Channel ports of Folkestone and Dover. During this period he was seconded to the South-Eastern Road Construction Unit, which was the controller for these government-funded projects, and held the positions of Project and Resident Engineer. With the rundown of the Road Construction Unit in 1980, he took up the post of Project Manager with a Chinese consultant, Peter Y.S. Pun and Associates in Hong Kong. Here he continued to gain experience in the planning, design and construction of major highway projects in Hong Kong and China. Since the end of 1981, he has held the position of Manager of the Civil Engineering Section at the Brisbane branch of Sinclair Knight and Partners, where he has been responsible for the design and construction of highway, urban developments and general civil engineering projects.