# PRACTICAL CONSIDERATIONS OF LABOUR BASED CONCRETE BLOCK PAVING IN MAJOR ROADWAYS

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**Summary**

Business, Development authorities and the new South African Government itself are under increasing pressure to establish projects and schemes with the potential to create employment and permanent empowerment of previously disadvantaged communities.

Infrastructural development and in particular the use of concrete block paving in roadways has great potential to address the needs of disadvantaged communities.

Existing technology in the application of concrete block paving and experience of projects in South Africa can provide sufficient data to enable engineers to successfully construct major roadways surfaced with concrete blocks.

There has been a number of block paving projects undertaken within the last 2 years with varying degrees of success. There are practical problems associated with these schemes which are discussed in this paper.

The need of long term upliftment and empowerment is more critical and important to the local community leaders. They feel that providing employment for the duration of a project is only a short term solution to the problem of economic upliftment. A successful approach to this problem is also covered in this paper.

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## Introduction

The socio-economic problems facing South Africa are enormous. From a population of approximately 44 million, estimates indicate a potential of 14,5 million people who could be economically active but there are almost five million unemployed.

This is a difficult problem to redress. There is no easy fix or quick solution but there is a spirit of determination that has grown since the first democratic elections. This determination must be harnessed to ensure continued improvements for all South Africans in the years to come.

The majority of rural and township areas suffer from high unemployment, low levels of skills and a rapid population growth rate. It is also these areas where development, in the form of infrastructure and housing, is most needed.

It is therefore logical to undertake development expenditure on projects which have a high level of labour utilisation and, at the same time, a suitably low level of skills requirements with the potential for training to improve skills of the workforce.

Concrete block paving used in roadways meet all these requirements. This method of road construction must not be restricted to minor and residential roads but must extend to more major roadways and arterials.

## Market Opportunity

The concrete block paving industry in South Africa was quick to see the opportunities if concrete blocks could be accepted as a desirable road surface.

Current usage in South Africa is ± 8 million square metres per annum made up from domestic (38%), commercial (16%) and industrial applications (46%). Block paving in roads could have a major impact on consumption volumes. An average main road contract is between 10 000m² and 20 000 m² of surfacing. Converting this to paving blocks would not only boost the industry but could offer enormous financial benefits to communities where these projects are undertaken. Labour based concrete block paving on roads can utilize up to 500% more labour than conventional mechanical road surfacing methods.

Scepticism from engineering professionals and from communities alike were to be expected and technical and promotional strategics had to be developed and implemented to overcome objections and reservations.

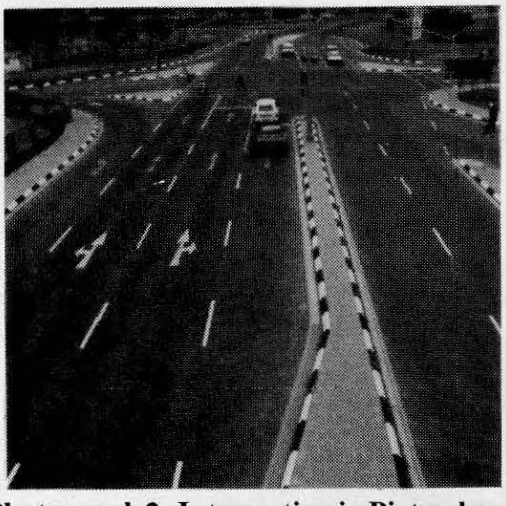
A few examples of block paved residential roads exist in South Africa which date back almost 30 years. These roadways are functioning well and require little or no maintenance. This clearly shows the suitability of block paving for urban roadways but it was necessary to prove the use

of concrete blocks on more major roadways which carry high traffic volumes and speeds in excess of 60 km/hour.

In 1989 the first major traffic intersection using concrete block paving was constructed in Pinetown, Natal. Although speeds were low, traffic volumes were very high. This intersection, which is still functioning perfectly, gave engineers and municipal authorities confidence in this type of application and many more intersections have now been constructed throughout South Africa.



**Photograph 1. Pinetown Intersection KwaZulu - Natal**



**Photograph 2. Intersection in Pietersburg Northern Province**

A project near the Northern Cape town of Aggeneys , has all roads constructed in concrete block paving. This development took place between 1979 and 1980 and included main access roads into the town. Although these roads do not carry high volumes, traffic speeds up to 120 km/h are commonplace.

This project, together with the experience of block paving in roadway intersections and information from other countries around the world, provided sufficient data to convince some authorities to undertake main road construction using concrete block paving.

**Concrete Block Paving used in roads**

*Technical Considerations*

Design details and specifications on the use of concrete block paving for roadways are available from the South African Bureau of Standards [1][2], The Council for Scientific and Industrial Research [3] and The Concrete Manufacturers Association [4].

However, it has long been the contention of road engineers in S.A. that concrete block paving is unsuitable for high speed, highly trafficked roadways. The reasons cited for the unsuitability were that high speed concrete block roadways generate excessive road noise which would prove unacceptable to the community as well as concerns as to the possibility of blocks being lifted out

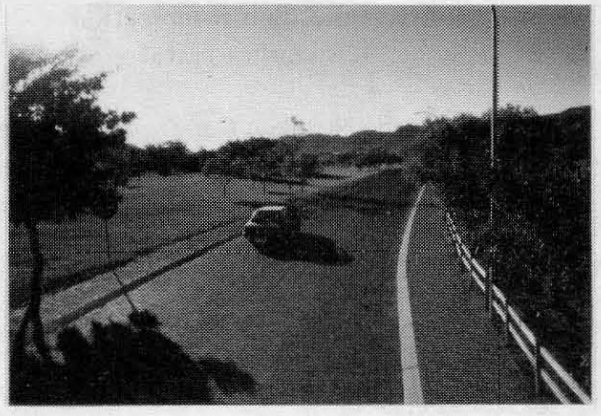
by high speed traffic. Cost was another limiting factor. Engineers generally considered concrete paving blocks as an upmarket solution which was much more expensive than traditional blacktop surfacing. It is ironic that the opposite view was held by many disadvantaged communities in that they felt the option of concrete blocks as a road surface was a second rate solution. Both these views have proven incorrect as the performance of a number of roadways constructed over the past 30 years can verify. The fear of design engineers regarding the durability of concrete blocks under severe traffic conditions has been allayed by the low maintenance costs of the roadways constructed.

*Project Experience in South Africa*

**Aggeneys .** Constructed between 1979 and 1980 a mine development near the Northern Cape town of Aggeneys used concrete block paving for all the access and residential roadways. The main access road to the mine has a design speed of 80km/h. Sixteen years later the roadway is carrying greater traffic volumes than originally estimated and at speeds up to 120km/h. The municipality has confirmed that no maintenance has been necessary on this road since trafficking commenced. The blocks have shown tremendous resistance to the temperature extremes in the area (-10°C to + 40°C) and to the abrasive effects of the high speed trafficking by the buses and other vehicles.



**Photograph 3. Main Access Road Aggeneys**



**Photograph 4. Residential Roads Aggeneys**

**Makwassie**. In 1984 the previous Government instituted labour creation projects in an effort to create employment for local communities. Municipal authorities were offered incentives for every labourer they employed on a project. One such scheme was instituted at Makwassie, near Klerksdorp in the North West Province. The engineering result was very successful. The community was employed to lay paving blocks manufactured by a local factory to form surfaced roadways in the municipal area. Minimal earthworks were carried out which involved the grading of the existing gravel roads to level and to ensure stormwater drainage. The blocks were laid under the supervision of the municipal engineers. The community immediately saw the

advantages of this type of roadway over the gravel roads and a community pride quickly developed.

**Witbank Freeway Shoulders.** Approximately 15 years ago the decision was made to use paving as a shoulder on a short section of freeway. This proved to be a very economic decision as the shoulders are still intact today having undergone little or no maintenance. The fact that the roads engineers were prepared to make use of concrete block paving in this application has added to the confidence of the product for higher speed roadways.

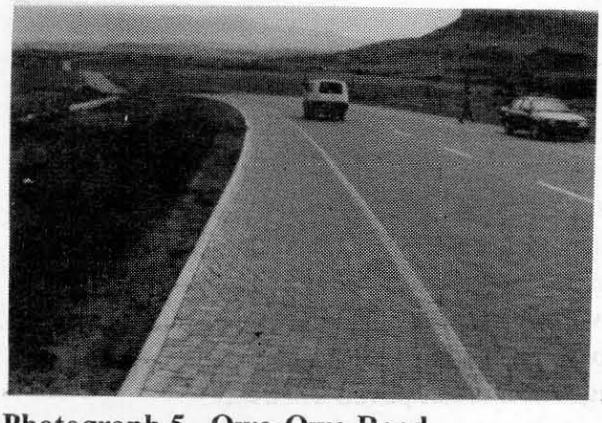
**Qwa-Qwa Road**. This project constructed during 1994 was the first major road surfaced entirely with concrete block paving. The road is approximately 10km in length with a cross section of ± 11m incorporating one lane in each direction with paved shoulders on each side. Kerbs are located at the outer edge of the shoulders and are flush with the road surface.

From the community perspective, this project was very successful in that many jobs were created. At times there were up to 130 persons employed on the block paving alone. It is estimated that 18% of the total contract value was returned to the community in the form of wages.

The paving blocks were supplied from a large manufacturing company which has an existing block plant adjacent to the site. Factory personnel were increased to achieve the required volumes and many local small business transporters were used to deliver the ± 115 000 m² of 80 mm thick paving blocks.

Although a large established main contractor was awarded the overall contract, the community were quick to "take ownership" of the block paved road. There now exists considerable civic pride in the finished roadway and any future road project will undoubtedly be block paving.

From a technical perspective the Qwa-Qwa road is also a success. As the main access to a commercial and residential area of approximately 300 000 people, traffic volumes are continuously increasing.



**Photograph 5. Qwa-Qwa Road Free State Province**



**Photograph 6. Intersection on Qwa-Qwa Road**

A speed limit of 80 km/hour exists on the road but as sections are in undeveloped areas, vehicles often travel at 120 km/hour. Noise levels are higher than black top roadways but this is not affecting the community in any way. Riding quality is well within acceptable standards.

We are indeed fortunate in South Africa to have block paved roadways that have been in place for a substantial period of time and that the ability of these roadways to withstand the abrasive effects of heavy traffic has been proven in the field. The proof of the ability of concrete block paving to cope in these situations is now available to all engineers but there is still a need for constant marketing from the industry to ensure that the knowledge and experience gained in new projects are passed on.

**Concrete Block Paved Roadways - Practical Considerations**

The purpose of labour based projects is firstly to create employment for the local community and secondly to impart skills to the work force that will offer the highest potential for sustainable income generation.

However, the project itself must be economically viable when using concrete block paving and it is essential a design team with experience is involved.

Items which will have the most significant cost implication are:

**a.** Earthwork design
**b.** Availability of correct quality paving blocks
**c.** Labour rates for payment to workforce.

These items should all be resolved before any tender process commences.

*Earthwork Design*

Methods of earthwork design are now well established and considerable data including computer programs are available.

As the use of block paving on major roads is relatively new to many engineers in South Africa, there is a tendency to "over design" earthworks. This has serious consequences as it overprices the block paving alternative and the inexperienced planner may reject blocks erroneously.

When comparing the construction cost of a block paved roadway to conventional bitumen surfaced roadways, recent tender prices have shown block paving to range from 98% to ± 113% of the price of bitumen. This is very competitive particularly if one applies a life cost exercise and includes a salvage value for the blocks. However most authorities are more concerned with current expenditure and if over designed earthworks push costs to 20% above alternatives, it is difficult to convince a client of the other advantages of a block paved roadway.

*Paving Block Supply*

The availability of adequate quality paving blocks is an area of great concern. Whilst the industry is attempting to ensure only quality products are used (to avoid deterioration and failure) the authorities and communities identify the production of blocks on site as a provider of jobs and a training and entrepreneurial development exercise.

There is merit in both sides of this argument and it is for the concrete block paving industry to develop strategies to meet the needs of both parties.

A rational approach would be to determine if there is any existing production facility within say 150 km of the proposed project. This facility should be investigated to ensure that it can meet the required block specifications, production quantities and delivery requirements. Accurate pricing can also be undertaken for the cost comparison exercise with other surfacings.

If no such production facilities exist, on-site manufacturing can be considered but this should be a last resort exercise. For on site production to be successful, the following is required:

**a.** Investigation on availability, suitability and cost of raw materials.
**b.** Machine type requirements to meet demand of the project.
**c.** Block testing facility requirements to ensure adequate quality control.
**d.** Possibility of plant gaining future work after completion of project (sustainability).

Experience in South Africa has shown that success is difficult with on-site production of blocks. This is mainly due to quality problems or cost overruns. The most successful projects have either been supplied by an established manufacturer or alternatively, on-site production has been a joint venture with an experienced paving block manufacturer.

The viability of on-site production should be evaluated not only by the planning and design teams, but also by an established paving block producer. This investigation should also examine the requirement for a testing laboratory and the cost implication this will have on the finished product. The needs for an adequate testing facility is essential when blocks are produced on site and any form of shortcuts in this regard can have serious consequences.

Block machine type and size must be assessed to be most compatible with project requirements and the ability to produce the correct quality blocks. Comparisons should always be made with products purchased from an existing manufacturer.

On site production of paving blocks tends to be more viable in rural areas where projects are a considerable distance from established production facilities. In these areas it is difficult to ensure any future sustainable business can be acquired. This is an unfortunate consequence of a rural roadway project where skills learnt by the community can be quickly lost.

*Labour Rates*

Labour rates can be a contentious issue and should be resolved at an early stage of planning.

It is becoming common practice in South Africa that any infrastructural project must be acceptable to the community it serves. After all, a labour based project should be to benefit the community not only in usage but also in employment during the construction phase.

It is therefore essential that the planning team, in conjunction with the community, agree on labour rates prior to any formal tender. Labour rates should be task based and not time based as task based is more conducive to productivity. However, tasks should be achievable so that a reasonable income can be attained.

*On Site Management*

When work commences on site it is important to remember the high volume of unskilled labour which is being utilised. It is for this reason that suitable and experienced site management is employed as this is critical for the success of a concrete block paved roadway project. Whilst considerable documentation, specifications and other literature exists detailing the correct methods and techniques for the construction of concrete block paving [1][2][3], this is not a substitute for experienced site personnel. It should be remembered that the communities are not only looking to the project for employment, but also for skills training. This will not be achieved without suitably experienced site personnel.

Typical examples of incorrect techniques the authors have experienced include:

1. Surface finish tolerances on earthworks too rough for concrete block paving.
2. Attempt to install kerbing after completion of paving.
3. No plate compaction carried out after sweeping in of jointing sands.
4. Areas of paving not completed each day ie. one day sequence must include screed bedding sand - place blocks - plate compact -sweep in jointing sand - final plate compact. Inexperienced contractors will often screed vast areas of bedding sand and leave it exposed for more than a day. Blocks are placed and again left for "days" before any attempt to plate compact. This causes the finished surface to be very uneven as the blocks will not bed and level correctly.
5. Finishing details are often very poor. Curved sections of roadways present the most problems which relate to the cutting of blocks at the kerb line. With care, no small pieces should be used and infill concrete should be avoided. Changes of direction in the paving pattern which occur across the roadway through corners should use a block to block detail. The use of insitu concrete beams should be avoided. Half blocks on one edge and careful cutting on the other edge will avoid any small pieces of blocks. This technique will also maintain a continuous flexible pavement.

It can be seen that the majority of problems related to labour based block paved roadways are relatively simple to overcome. As experience in this type of project increases, particularly with the planners, authorities and engineers, the quality of finish to these roadways will continuously improve.

## Conclusion

*Future for the communities*

There can be no doubt that roadways constructed using concrete block paving offer considerable opportunities to previously disadvantaged communities. Employment is created, skills are learned and a valuable asset is created.

However, the problem of sustainability of income for these communities after completion of the project has become a major concern of the Government, Development authorities, Community leaders and the block paving industry. The concept of manufacturing the paving blocks on site is not a solution as continued demand for paving blocks may not exist.

A project undertaken in the Northern Province has attempted to address the problem of sustainability with some success.

The project called for a taxi rank and access roadway to be constructed using concrete block paving. The community called for the paving blocks to be manufactured on site along with the necessary kerbing.

An established manufacturer of block paving offered an alternative to the community whereby the supplier would establish on site production of the kerbs and also a small hand operated machine to make building bricks. The block paving was a direct supply from the established manufacturer. This proposal was accepted by the community, the project engineers and the funding authorities and was considered successful for the following reasons.

**a)** The community were involved in the decision making process.
**b)** The on site production was of a manageable scale for the community to learn the production process and the management skills.
**c)** There is a continuous demand for building bricks therefore sustainability can be achieved.
**d)** The paving blocks supplied were to a guaranteed specification standard.

This approach is now planned on other projects. It is believed that all parties involved will benefit and the finished product will be to a suitable engineering standard.

*Future for Concrete Block Paved Roadways*

South African manufacturers have made major strides over the past 10 years in changing the attitudes of roads engineers and communities towards the use of concrete block paving in roadways.

Old concerns are being dispelled with each new project which is successfully completed but care is necessary to ensure continued success.

Technology and engineering skills are available to professionals and considerable knowledge exists as a consequence of existing projects. Community involvement and a high standard of on site management are essential.

Our advantage is that we have a first world solution to the third world problem of upliftment of the masses and empowerment of the people. Concrete block paving is an ideal product for labour based roadway projects with an end result that is technically excellent.

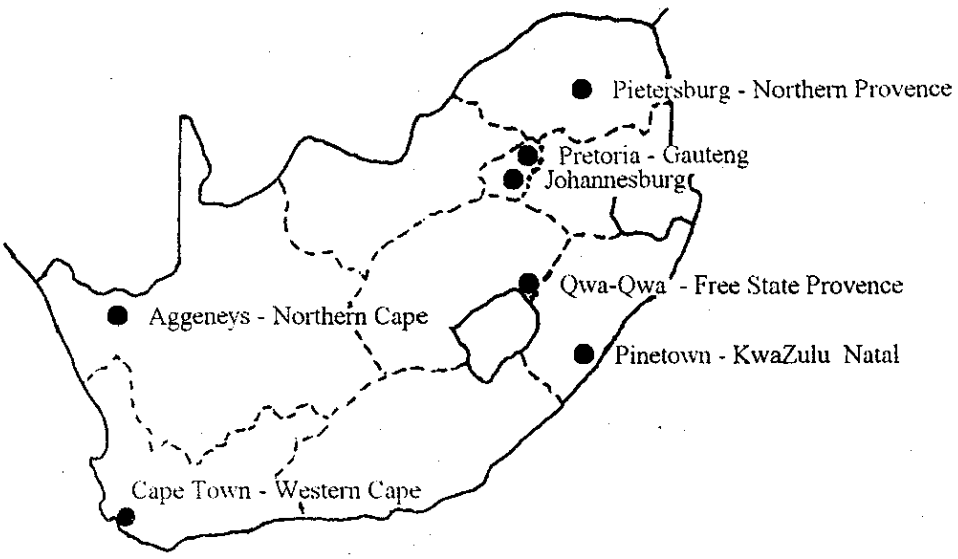



**Figure 1. South Africa**

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