CONCRETE BLOCK PAVING

An Introduction to Permeable Concrete Block Paving

Environmentally friendly, allowing the ability to re-use scarce water resources

CONCRETE MANUFACTURERS ASSOCIATION
Quality cast in concrete

INTRODUCTION

This document is intended to help all those involved with the development process – including designers and developers, and planning, building control and adoption officers – understand permeable concrete block paving. It deals with practical issues and explains the different systems and techniques available, and how they can be used to meet current demands. It considers the planning process, overall design, long-term performance, costs and adoption issues.

The need for sustainable drainage

The continuing growth in urbanisation and ambitious government driven housing programmes, combined with more extreme weather events linked to climate change will increase the potential of flooding and cause damage to houses and infrastructure. Clearly, a sustainable approach to all surface drainage is needed to deal with existing overloaded systems and to accommodate future growth. It is now well recognised that Permeable Concrete Block Paving (PCBP) offers the solution.
PCBP is a design philosophy which, when using a range of

techniques in a sequence, is known as a management train. PCBP manages surface water by attenuation and filtration with the aim of replicating, as closely as possible, the natural drainage from a site before development. The three pillars of PCBP are to:

- minimise water runoff QUANTITY
- improve water QUALITY
- provide AMENITY and biodiversity.

PCBP is the most versatile PCBP technique, with important attenuation and pollution source control characteristics. PCBP is a deceptively simple concept, providing an attractive pavement surface suitable for trafficking that also acts as a drainage system. It has been in use throughout the UK, Europe and other parts of the world for decades, resulting in extensive information and experience. However, it is only now that this adaptable technology, along with other sustainable approaches to drainage, is being demanded on all developments to reduce flooding and pollution.

CMA's role

PCBP is a unique sustainable drainage technology which is being championed by the Concrete Manufacturers Association (CMA), representing all the major precast concrete paving manufacturers in South Africa. Its block paving manufacturer members maintain the highest standards of quality control, product innovation and sustainability. The CMA has the expertise, international contacts and resources to develop technologies such as permeable paving to the benefit of the building industry as a whole. The CMA works closely with other organisations such as the CSIR and the Environmental Council in driving forward sustainable drainage solutions. Its manufacturing members continue to develop innovative permeale concrete block paving products and systems.

PERMEABLE PAVING PRINCIPLES

In conventional pavements, rainwater is allowed to run across the surface to gulleys that collect and direct it into pipes,removing it as quickly as possible. This means that water with the pollutants contained in it are rapidly conveyed into overloaded drains, streams and rivers, leading to floods in extreme conditions.

In contrast, PCBP addresses both flooding and pollution issues. It also has a dual role, acting as the drainage system as well as supporting traffic loads. PCBP allows water to pass through the surface – between each block – and into the underlying permeable sub-base where it is stored and released slowly, either into the ground, to the next management stage or to a drainage system.

Unlike conventional road constructions, the permeable sub-base aggregate is specifically designed to accommodate water. At the same time, many pollutants are substantially removed and treated within the PCBP itself, before water infiltrates to the subgrade (ground) or passes into the next stage of the management train.

Products

There is a growing choice of concrete blocks available from CMA manufacturers, designed specifically for permeable paving. Essentially they have the same impressive performance as conventional precast concrete paving products, including durability and strength. Various shapes, styles, finishes and colours are available allowing real design freedom.

The difference with PCBP is enlarged joints or holes in the corners of the pavers. These joints/holes are subsequently filled with a joint filling material specific to each product, which is an angular aggregate, not sand. This arrangement ensures that water will continue to pass through the joints /holes over the long-term. It is fundamentally unlike pervious materials.

PCBP offers a major benefit in modern urban design, enabling accessible shared surfaces to be created without the need for cross falls, channels or gulleys, while still avoiding standing water.

For further information on specific block types, contact the relevant CMA manufacturer via www.cma.org.za.

System selection

One of the key criteria in selecting a PCBP system is the permeability of the existing subgrade (ground), which is established from tests on site.

More information can be found on the CMA PermPave Design CD, which also recommends appropriate pavement systems for a range of subgrade (ground) conditions. It also offers a number of other factors that need to be considered when choosing which is the most appropriate system for a site, including:

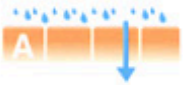
- Ground Water Table Level
- Pollution Prevention
- Discharge Consents
- Proximity to Buildings

Finally, different techniques for the application of PCBP to meet specific project requirements, discussed later, are suited to particular Systems (as identified using the symbols that follow).

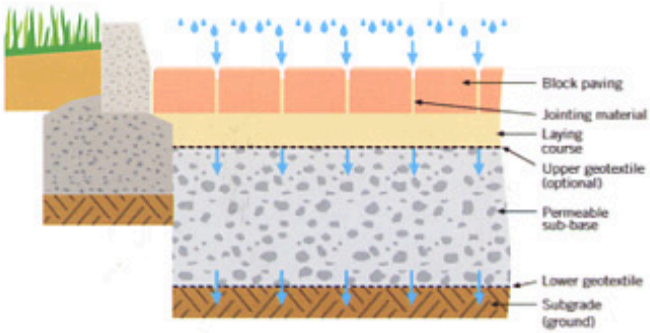
Systems

There are three different PCBP systems, described as Systems A, B and C. There is no difference between the surface appearance of the different Systems but each has unique characteristics making it suitable for particular site conditions.

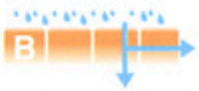
System A – Full Infiltration



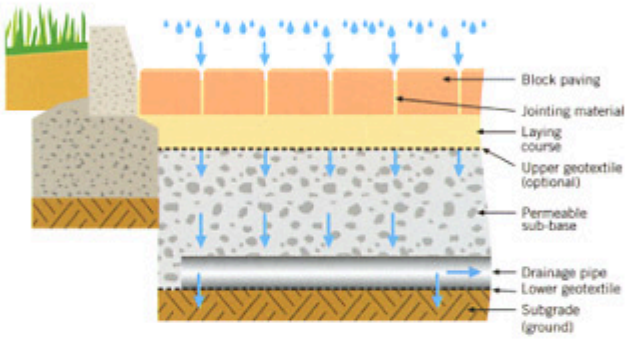
–suitable for existing subgrade (ground) with good permeability, System A allows all the water falling onto the pavement to infiltrate down through the constructed layers below and eventually into the subgrade (ground). Some retention of the water will occur temporarily in the permeable sub-base layer allowing for initial storage before it eventually passes through. No water is discharged into conventional drainage systems, completely eliminating the need for pipes and gulleys, and making it a particularly economic solution.



System B – Partial Infiltration

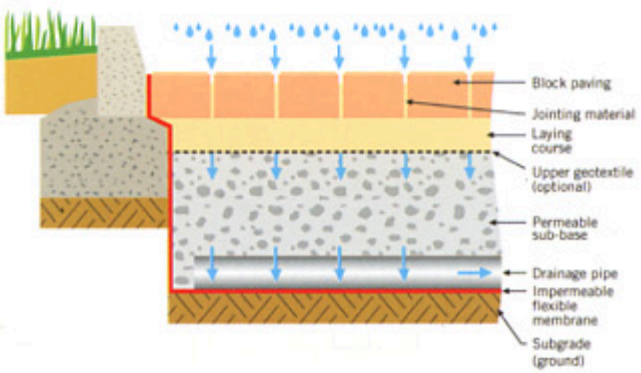


– used where the existing subgrade (ground) may not be capable of absorbing all the water. A fixed amount of water is allowed to infiltrate – which, in practice, often represents a large percentage of the rainfall. Outlet pipes are connected to the permeable sub-base and allow the excess water to be drained to other drainage devices, such as swales, ponds, watercourses or sewers. This is one way of achieving the requirement for reducing the volume and rate of runoff and will most likely remove the need for any long term storage.



System C – No Infiltration

– where the existing subgrade (ground) permeability is poor or contains pollutants, System C allows for the complete capture of the water. It uses an impermeable, flexible membrane placed on top of the subgrade (ground) level and up the sides of the permeable sub-base to effectively form a storage tank. Outlet pipes are constructed through the impermeable membrane to transmit the water to other drainage devices, such as swales, ponds, watercourses or sewers. System C is particularly suitable for contaminated sites, as it prevents pollutants from being washed further down into the subgrade (ground) where they could reach groundwater.



PERMEABLE PAVING PERFORMANCE & BENEFITS

There are three well-known pillars which PCBP successfully achieves:

- Quantity – management of rainwater and avoidance of flooding
- Quality – removal and treatment of diffuse pollution from runoff
- Amenity – improvement of the external environment.

In addition, PCBP offers a range of other unique benefits and opportunities.

Quantity – rainwater management

PCBP deals with surface water close to where rainfall hits the ground. This is known as 'source control' and reduces the peak rate, total volume and frequency of runoff and helps to replicate green-field runoff characteristics from development sites. A study by H. R. Wallingford (Kellagher and Lauchlin 2003) confirms that PCBP is one of the most space-efficient systems components available, as it does not require any additional land take. In fact, it can handle runoff from roof drainage and adjacent impermeable surfaces, as well as rain falling on the PCBP itself.

Quality – handling pollution

PCBP is very effective at removing pollution from runoff, unlike conventional drainage systems - which effectively concentrate pollutants and flush them directly into drains, watercourses and groundwater. The pollutants may either remain on the surface or be flushed into the underlying pavement layers, where many are filtered and trapped, or degrade over time.

The capabilities of PCBP in handling pollution are summarised in the table (above right). Oil separators are not required when PCBP is used. Permeable pavements are actually more effective at removing a wider range of pollutants from runoff than oil separators.

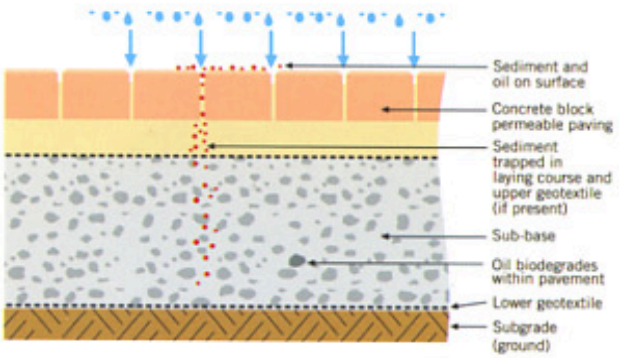
Percentage Removal of Pollutants
Total suspended solids 60-95%
Hydrocarbons 70-90%
Total phosphorus 50-80%
Total nitrogen 65-80%
Heavy metals 60-95%
Water Quality Treatment Potential
Removal of total suspended solids High
Removal of heavy metals High
Removal of nutrients (phosphorus, nitrogen) High
Removal of bacteria High
Treatment of suspended sediments & dissolved pollutants High

Amenity – improving the environment

PCBP is used on projects ranging from footpaths to container terminals, with the reassurance of proven engineering design solutions for every type of application. In addition to the visual design possibilities discussed earlier, PCBP offers two fundamental benefits compared with conventional surfacing:

- completely level, well-drained, firm and slip-resistance surfaces
- an absence of channels, gulleys and other interruptions.

As a result, PCBP meets current accessibility requirements for the whole community – unlike loose materials such as gravel, suggested in some guidance on permeable paving but specifically excluded by accessibility rules. Particular benefits include eliminating 'ponding', reducing the risk of ice forming on the surface and no rain splashing from standing water. These aspects are particularly important for accessible shared surfaces, eliminating the need for cross falls, channels or gulleys. This capability for completely level pavements is helpful in other applications as well, for example level car parking areas for supermarkets, making it easier to control trolleys, in container yards to meet specific operational requirements or areas used by forklift trucks. From an ecological perspective, PCBP also avoids the "death traps" which open gulleys present to wildlife and provides sustenance to nearby trees and plants.



Service life and maintenance

PCBP technology has proven itself over decades of successful use around the world. One issue that is well understood is the performance of the block paved surface. The infiltration rate of PCBP will decrease due to the build-up of detritus in the jointing material, then stabilise with age – as summarised in the graph below.

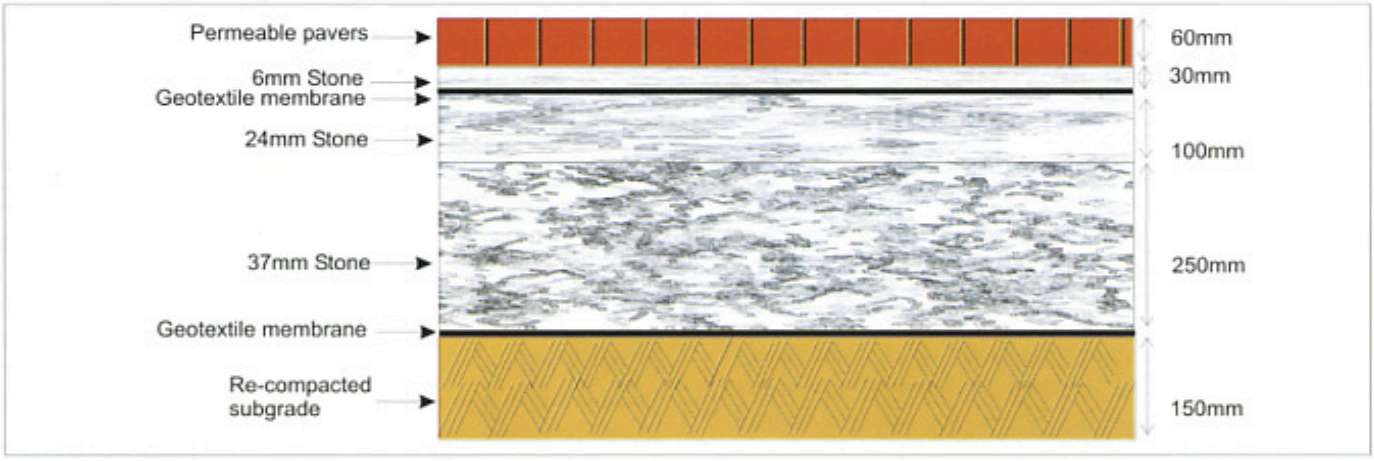
American and German experience recommends that the design infiltration rate through the surface should be 10% of the initial rate, to take into account the effect of clogging over a 20-year design life without maintenance. Even after allowing for clogging, studies have shown that the long-term infiltration capability of permeable pavements will normally substantially exceed requirements. The percolation rate through joints of newly laid PCBP is 4000mm/hour, so even allowing for the reduction to just 10% discussed above, there is still a large factor of safety. Recommended maintenance is minimal – no more extensive than that for conventional block paving and less than for conventional gulley and pipe drainage. Also, any problems with PCBP become apparent on the surface with a visual inspection, unlike the below-ground inspections needed for pipe drainage.

Benefits of Permeable Concrete Block Paving
• providing a structural pavement while allowing rainwater to infiltrate into the pavement construction for temporary storage
• playing an important part in removing a wide range of pollutants from water passing through
• allowing treated water to infiltrate to the ground, be harvested for re-use or released to a water course,the next management stage or other drainage system
• suitable for a wide variety of residential, commercial and industrial applications
• optimising land use by combining two functions in one construction: structural paving combined with the storage and attenuation of surface water
• handling rainwater from roof drainage and impervious pavements as well as the permeable paving itself.

PERMEABLE PAVING IN SOUTH AFRICA

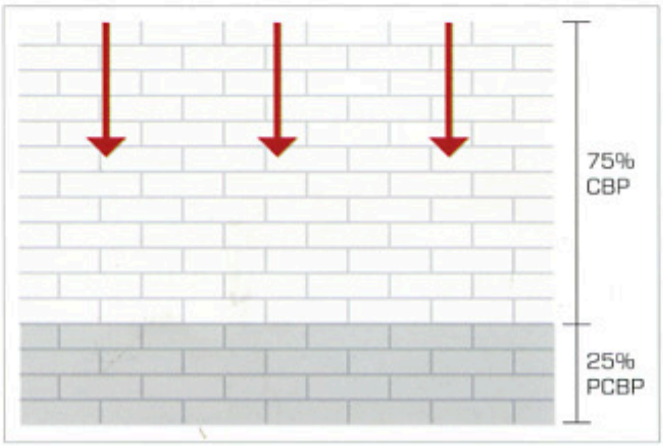
1 Wits University – Empire Road, Johannesburg

13 000m² of car parking on 2 levels. The current stormwater system on Empire Road could not cope with the additional run-off from the parking area.



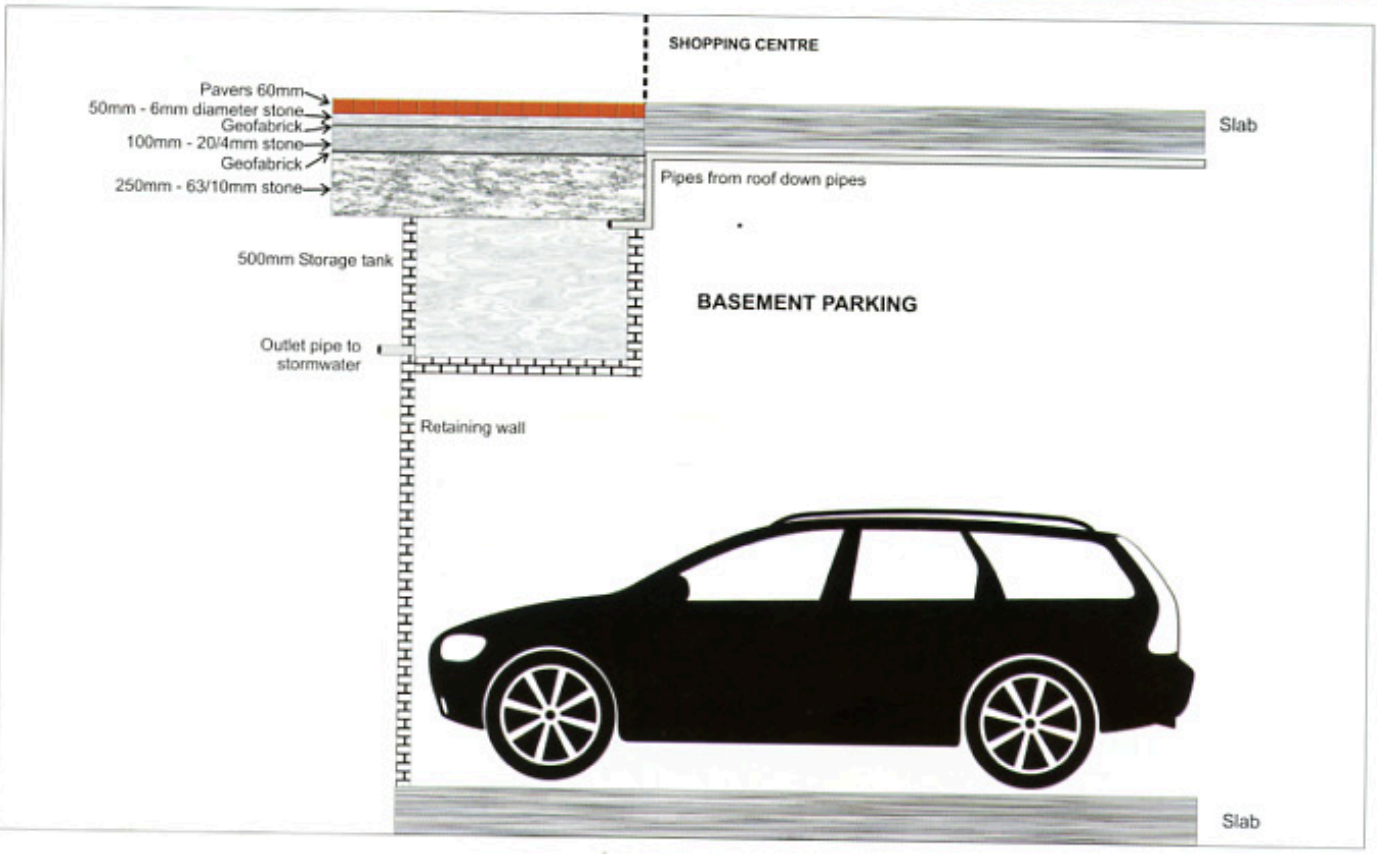
2 Grand Parade, Cape Town

A 10 000m² multi-purpose area which combines conventional CBP (75%) with PCBP (25%) the falls are designed so that the water runs across the conventional paving onto the PCBP. This is a partial infiltration system where some of the water infiltrates directly into the ground and some is collected into a pipe and released into the stormwater system at a controlled rate after the stormwater has subsided.



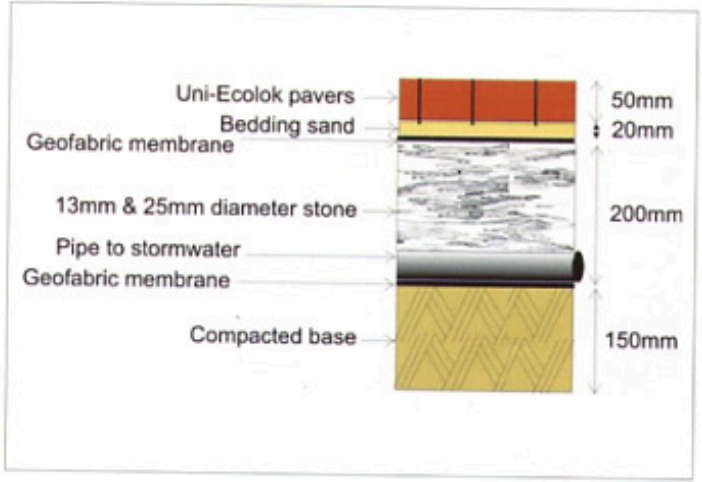
3 Kensington Boulevard, Durban North

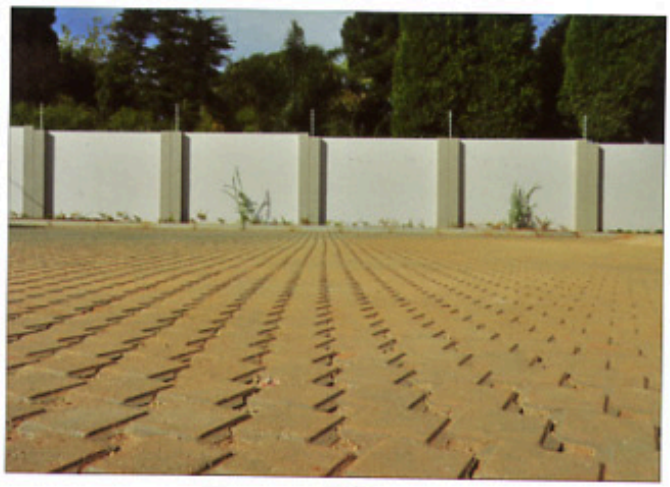
The existing stormwater system could not cope with the additional run-off especially from the roof of the new shopping complex. In addition to the PCBP used in the external walkway of the shopping complex, a water tank was constructed in the parking basement to collect all the water from the roof. This water was discharged at a controlled rate into the stormwater system after the storm had subsided.



4 Boeing Road East, Bedfordview

This office parking area used the pavers with holes in rather than enlarged slotted joints. It again used the partial infiltration system.





PAVING MEMBERS (MARCH 2010)

Bafokeng Concor Technicrete	014 538 0818
Baybrick	035 792 5218
Bosun Brick Midrand	011 310 1176
Bosun Brick Brits	012 250 1711
Brick & Concrete Industries (Namibia)	00264 61 321 3009
Brickcast Industries	031 507 5525
Brickbuild T/A Panda (Botswana)	00267 244 2106
Cape Brick	021 511 2006
C.E.L. Paving Products	021 905 5998
Cast Industries	011 316 2375
Columbia DBL	021 905 1665
Conframat	016 987 3381
Corobrik	031 560 3911
Deranco Paving	041 933 2755
Inca Concrete Products	021 904 1620
Inca Masonry Products	043 745 1215
Infraset Gauteng	012 652 0000
Infraset KZN	031 569 6900
Kopano	016 363 0340
Kwena Concrete Products (Botswana)	00267 392 2850
Mobicast Mossel Bay	044 874 2268
MVA Bricks	012 386 0050
Neat Contech	046 624 3377
Stanger Brick & Tile	032 457 0237
Stone Age Concepts	012 802 1496
Technicrete	011 674 6940
Vanstone Precast	012 541 2056
Watson Concrete	011 740 0910
West End Bricks	011 851 1828

ASSOCIATE MEMBERS

Inca (Cape)	*021 904 1620*
Smartstone	*011 310 1161*

CONTRACTOR MEMBERS

Daron Construction	*034 955 1333*
Galaxy Paving	*011 815 1175*
Mondo Paving & Retaining Walls	*011 708 0800*
PYW Paving	*031 903 1736*
Roadstone Civil & Paving	*011 683 7080*
S A Paving (Gauteng)	*011 483 1350*
Sun Paving	*031 705 5123*
The Paving Creations	*031 765 4083*
Vesles Civils	*012 662 3031*
Valcal International	*011 867 2471*

Isikhova / 1738 / 2010

CONCRETE MANUFACTURERS ASSOCIATION
Quality cast in concrete

Block D, Lone Creek, Waterfall Office Park, Bekker Road, Midrand.
PO Box 168 Halfway House 1685
Tel +27 11 805 6742, Fax +27 86 524 9216
e-mail: main.cma@gmail.com website: www.cma.org.za