



Parking tracks with Terracrete

### Creating Permeable Surfaces with Terracrete

*The days of slapping concrete and asphalt down to make a paved trail walkway, or driveway may be numbered. Commercial properties, public spaces, and residential developments have upped the standard on what they require from a paved surface. Land restrictions, storm water management, and other environmental regulations have turned the growing housing market and other land developers to seek solutions that can address these issues. Karin Johns investigates whether permeable interlocking concrete pavers could form part of the solution.*

### Unbridled Urbanisation

Unrestrained urbanisation is a major problem in many parts of the world. In South Africa an estimated 4/5 of the population live in urban areas. In combination with poor farming practices, this leads to rapid degradation of our rivers and streams. Apart from our precious soil disappearing down to the beach, so are our undernourished ground water reserves, our biodiversity doing likewise.

This effect of urbanisation on catchment water balance has been thoroughly researched and documented to the Water Research Commission by Professor D. Stephenson and others of the Water Systems Research

Group at Wits University, whose research findings state the following:

"In nature a semi-equilibrium exists between precipitation, runoff and infiltration into the ground. Over years the water table fluctuates about a mean. The construction of impermeable barriers on the surface, such as roads and buildings, reduce the rate of ground water replenishment.

"The water runs off easier and the limited permeable areas restrict infiltration. The groundwater level will therefore drop and the zone above the water table will gradually dry out. Vegetation and the soil characteristics will change. If we are not to affect our environment adversely we should attempt to return some of the storm-water we channel off urban areas back to the ground."

### Permeable paving

Part of the solution is offered by permeable interlocking concrete pavers (PICP), similar to the traditional pavers contractors have installed for decades. Interlocking shapes, notched corners, or enlarged joints between PICPs allow for water infiltration. These void spaces can provide enough permeability to significantly reduce storm water runoff, provided that the openings are filled with aggregate mixes permeable to water.



Rustic Driveway



Permeable walkway

Speaking at the International Concrete Conference & Exhibition (ICCX), Cape Town 2007 on February 15th, Dr Sönke Borgwardt, self-employed Landscape Architect and consulting engineer, Certified Auditor for block paving jobsite monitoring and authorised legal expert at regional, supreme and appealation courts in Germany adds that the use of permeable paving is an important contribution to a sustainable and environmentally useful management of drainage systems.

"The handling of storm water runoff from sealed traffic areas is made less complicated and more affordable when it is decreased considerably by the application of infiltratable pavements."

Permeable pavement surfaces temporarily store rainwater runoff before infiltrating it into the subsoil. The resulting porous surface replaces traditional pavement, allowing rainwater that would normally runoff into rivers and streams, to infiltrate directly into the soil while improving water quality. Hydrocarbons from cars, pet waste, nitrogen, and other pollutants are filtered and removed by bioremediation, before polluting the ground water.

This type of infiltration management, according to Dr Borgwardt, has the added benefit that the already overstressed urban sewer systems are relieved. A further advantage is that secondary drainage measures, such as channels or swales, as well as detention ponds, can



Driveway for light traffic

it to the ground beneath. Permeable surfaces have three main components:

### 1. Surface materials

Allow some water penetration in or through the material to the ground below.

### 2. The underlying construction (sub-base layer)

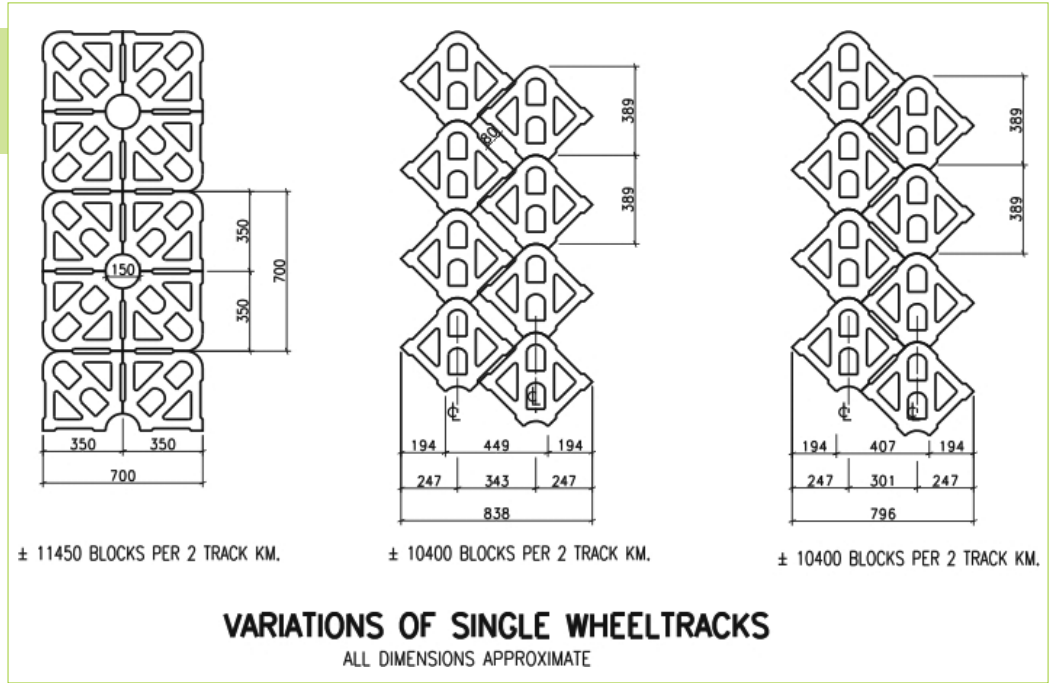
A free draining sub base layer such as gravel must be used underneath the surface materials. You can check the suitability of your local sub-base material with an engineer. A gradient or fall away from traffic areas may also be part of a successful drainage solution. Sand, fine crushed stone or recycled aggregate may have to be added to coarse gravel to improve on compactability, without losing drainage capabilities.

The thickness of the sub-base layer is determined by permeability of the sub-soil (has to be determined with suitable test methods), make-up of sub-base and amount of storm water that has to be stored short term in this reservoir before infiltrating into sub-soil or draining away to secondary detention ponds. Water infiltrated under areas with fair traffic needs to be drained with a good sub-surface drainage system without delay. Permeable paving is not suited for high traffic areas.

### 3. The supporting soil (sub-grade layer)

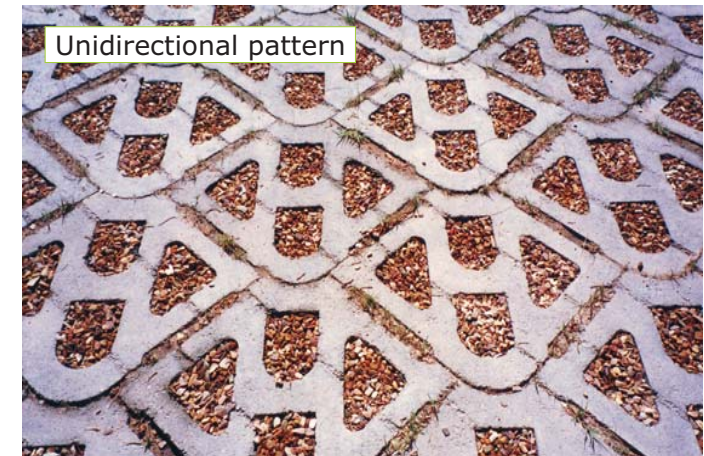
The permeability of this layer is critical to a successful permeable paving solution, especially on heavy clay soils. Heavy clay sub-grade layers act as a water barrier and can prevent the proper function of a permeable surface treatment.

According to Dr Borgwardt, available permeable concrete pavers can be divided into porous concrete blocks, permeable blocks with widened joints and permeable



concrete blocks with drainage openings and joints.

**Porous concrete blocks** are permeable within themselves because of increased volume pores. The rainwater can be absorbed and passed on by the paver. They are suitable for lower traffic areas in terms of traffic load and quantity, such as private residential areas.



Unidirectional pattern

be greatly reduced.

This, in addition to the reduction of water velocity achieved by permeable surfaces, has a tremendous effect on offsite flooding, erosion, and eco-systems. Stream and creek beds are spared erosion and higher temperature waters caused by increases in velocity and pollutants normally associated with impermeable runoff.

Higher water temperatures are detrimental to fish, aquatic vegetation, and other animals. Erosion due to increased velocity is harmful to mature trees.

### What is permeable paving?

Permeable paving allows water to be absorbed through

**Permeable concrete blocks with widened joints** are provided with separate and loosely attached or with integrated and permanently fixed spacers that allow joints usually between 15 and 35 mm. When used with integrated spacers this system can tolerate slightly higher traffic loads such as parking areas with less traffic frequency.

**Permeable concrete blocks with drainage openings** are developed from conventional formats with additional openings in the paver or at its side. These drainage openings can be in the form of holes, hollow spaces, cavities or chambers. Usually a proportion of 10% of opening ratio is achieved. They can be utilized with heavy load traffic, especially with interlocking formats.

### Versatile eco-surface

Terracrete, manufactured locally by Terraforce licensees, is a versatile eco-surface hard lawn paving block that was introduced to the South African market by Terraforce in 2002.

The units can be laid in different patterns and may be used with or without ground anchors for the lining of riverbanks and other areas subjects to soil erosion. The paving of grassed roads and parking areas, as well as the stabilising of steep embankments such as bridge



abutments can be undertaken with these versatile blocks.

According to Rust, Director and Founder of Terraforce, South African and International pre-cast concrete manufacturer, Landscape Contractors have recognised the many benefits of installing permeable interlocking concrete pavers. "From an aesthetic point of view, they are very versatile, adds Rust. "The homeowner or the developers want the house to look good."

A grass driveway, a rustic gravel driveway, or an attractive pattern of pavers can add the finishing touch to a custom home looking to stand out. Permeable grass pavers can add a park-like or pastoral feel to many areas normally needing hard paving.

Designed with sufficient strength and adequate stiffness Terracrete pavers are capable of accommodating (with suitable sub-base construction and in combination with ground anchors) vehicular traffic and the substantial uplifting forces caused by high water velocities.

### Local applications

In Gauteng, the Johannesburg Regional Association (municipality) or JRA as well as other Gauteng municipalities, have adopted a practical storm water and river management approach in order to reduce

flooding and control erosion, caused by ever expanding urbanisation.

To help the control of rain water run off, all new developments in Gauteng, whether residential, commercial or industrial, are now obliged to provide attenuation ponds, which capture the sudden increase in water caused by highveld storms, and releases it at a slow rate into either the storm water system or directly into streams and rivers.

This effectively helps to manage water run off, which minimizes damage, siltation and the relevant costs associated with repairs, consequential damage, and provisions by either the affected municipality or provincial government to incur costs for "down stream" measure



controls.

The almost fully completed "Chilli Lane" shopping centre in Sunninghill, Johannesburg is constructed along the 'Sandspruit' river which flows directly out of Johannesburg with several tributaries joining the flow along the way. Storms result in flash flooding, which reaches its peak as it flows towards the Crocodile River and into Hartebeespoort Dam. All the run off from the roof and the paved parking area will be controlled by an attenuation pond built using Terraforce L11 blocks, supplied by ReMaCon Products cc.

The design had to accommodate wall heights of over 5m and included a 'double skin' layer of Terraforce L11 at a 65° wall angle, the blocks were filled with 19 mm stone as well as a filter medium behind the block wall consisting of a 300mm deep layer of 19 mm stone, with a geotextile water transmissive filter fabric between the stone and the soil embankment to allow for rapid draw-down drainage.

In addition, a parking area was required at a level below the 100 year flood line, conventional paving or tar surfaces were not permitted as this flat area would contribute to run off as well as accelerated river flow during flooding – exactly what is not needed to prevent down stream damage. The choice to use a grass block paved surface was made to slow down run off and flooding, the Terracrete 100mm thick (machine made) grass block was supplied by ReMaCon and installed by the civil contractor, Roadline Civils.

As the parking area was meant for traffic, the choice of coverage had to be for the densest pattern at 9 blocks per m2.

### Terracrete Moulds

As part of the ongoing battle to save our ground water



reserves, Terraforce has designed mould boxes made of U.V. stabilised LLDPE (polyethylene) that can be used for the production of Terracrete wet-cast grass-pavers (hard-lawn).

Polyethylene is a durable non-stick plastic and the boxes weigh approx 2kg each and have adequate stiffness to be used on a vibrating table with a semi-wet mix and for immediate demoulding onto plywood pallets or other firm non-stick surface.

The process does thus not require large investments in terms of infrastructure or equipment. It is ideal for start-up operations or for market testing. Between 250 and 400 units can be produced per mould and workday.

- **Cost of moulds ± R200.00 or US\$ 32.00 or EU 25.00 each - to appointed licensees only.**
- **Proposed mix by volume: 5 parts sand / 5 parts 6mm stone / 3 parts cement.**

The moulds were successfully implemented at The Teal and Trout country estate situated in the highlands between Dullstroom and Machadadorp which falls within the Montane Grassland Biome and represents part of the water sponge for this part of South Africa.

A stream that carries no less than 5 million liters of fresh water per day through secluded valleys with 18

dams and six stone weirs, supports a wide biodiversity in fauna and flora, free of invasive plant species. With many kilometers of access and service roads in place, there arose a need to protect vulnerable road sections against soil erosion.

The system of producing Terracrete hard-lawn blocks on-site with inexpensive plastic moulds was chosen for the following reasons:

- a. Low machinery and equipment input.
- b. Produced on-site by local labour as and when required.
- c. Easy installation by local labour.
- d. Attractive patterns and adaptable to many site conditions.

In the words of the developer, "We have found this form



of road stabilization to be indispensable in wet rainy weather. It completely halts erosion and also looks very neat. Much more pleasing than soil or gravel roads, which are so prone to soil erosion. Traction for vehicles is enhanced considerably as well."

Without a doubt, installing these preventative measures cost more than soil or gravel roads, but long term, the savings in maintenance costs will recover those expenses.