GRASSCRETE®

CAST INSITU PAVING SYSTEM

STORMWATER MANAGEMENT: THE CASE FOR POROUS PAVING

GRASS CONCRETE LIMITED

PART OF THE GC GROUP OF COMPANIES

INTRODUCTION

Architects and Engineers throughout the world are becoming increasingly aware of the effects of creeping urbanisation on our environment: "Mitigation of environmental impact" is now a commonplace element on the planners check list.

As we move away from the "paint it green" approach of the early days of public consciousness to evolved sustainability, the demands upon ingenuity become even greater.

Unfortunately, it often takes a catastrophy to focus resources towards environmental dangers which lurk around the corner.

This is no more apparent than in the provision of flood defences. Those 1 in 100 years barriers seem to be breached with alarming regularity as we struggle to cope with the combination of a changing climate and increased surface water run-off.

THE NEED FOR ALTERNATIVE STORM WATER MANAGEMENT APPROACHES

Urbanisation of woodland or agricultual land has a profound impact on the hydrology of the immediate and neighbouring areas. Two principle factors account for this impact:

1. The percentage of surface area taken up by roof tops or hard paving.
2. The percentage of land served by storm sewers.

Traditionally, the aim of a stormwater management system has been to collect, conduct and dispose of stormwater as efficiently and quickly as possible. Once "run-off" is generated by rooftops, streets and car parks, it is immediately conveyed to storm sewers. This method of stormwater management has three major effects on the hydrology of the developing area.

- I. Urban development increases peak run-off.
- II. Peak flow velocity and lag times are modified.
- III. Water quality is degraded.

<u>Urban Development Impact on Volume and Peak Flow</u>

The increased filtration characteristics of streets, rooftops and car parks means that the peak volume of run-off is much higher. In areas of especially heavy urban use such as shopping centres, business districts and housing estates, the peak volume of run-off can be six times as high as the same area prior to development.

Stormwater drains more rapidly from streets and roofs than from areas covered by natural vegetation. In addition, stormwater is conveyed to main watercourses far more efficiently by way of gutters, drains and sewers than as previously via ditches and minor streams. The time interval between storm precipitation and resultant run-off, or "lag time", is thus reduced significantly by urbanisation.

Increase in peak flow can have a number of impacts downstream:

As the stream attempts to accommodate the increase in volume and velocity of storm water, it will loose stability. Stream bed and bank erosion with associated sedimentation will result. Increased peak flows will increase the frequency of downstream flooding. This can cause extensive inconvenience and financial loss.

Subject to local geology, the increase in total run-off and the decrease in lag time may result in less sub-terranean water table recharge: this reduction ultimately results in decreased dry weather flows, therefore, urban development not only increases flood peaks during storms, it may also decrease stream water levels between storms. This, in turn, reduces the viability of some elements of the flora and fauna inhabiting a stream and thus debase the quality of life.

NEW DIRECTIONS

In response to downstream flooding problems, some authorities have considered legislation directing land developers to reduce the excess run-off associated with land development. Such legislation would, in turn, cause a re-definition of stormwater management objectives. Stormwater storage reservoirs and floodparks are often the only methods available to alleviate potential flooding downstream of ‘new towns’ or low lying (perhaps tide-locked) areas.

These proposals have fostered the development and use of new methods. The aims of innovative stormwater management are quite different from the aims of traditional methods. Past practices have emphasised the quick elimination of stormwater. In contrast, the aims of innovative stormwater managements are to maintain natural run-off levels by providing opportunities for infiltration thereby controlling the velocity of run-off, extending lag time and reducing the volume of run-off.

Current considerations emphasise the maintenance of pre-development run-off levels through on-site controls.

Where traditional stormwater management has utilised kerbs and gutters to quickly convey stormwater to drains, new approaches in the USA use roadside ditches to slow drainage and allow for infiltration. New techniques emphasise the use of natural drainage systems with their low velocity flow characteristics and opportunities for groundwater recharge.

Conventionally, rooftops and car parks have been designed to drain quickly.

New Retention Systems utilise the ponding of stormwater in rooftops and car parks to provide storage of stormwater. In contrast to past practice, developers construct retention or detention structures to keep stormwater on the site. Temporary storage may be provided in drainage swales and depressions. There, stormwater is detained and allowed to either infiltrate into the soil or is slowly released after the storm event.

Porous pavements shows potential as a technology in maintaining pre-development run-off levels by allowing for infiltration and groundwater recharge. By acting as a retention device, these pavements can decrease the quantity of peak flows and increase lag time of the movement of rainwater from its origin to stream channels. This would minimise stream bank and bed erosion and related sedimentation further downstream thereby maintaining or improving water quality and habitat. Thus the technology of concrete porous pavements shows promise as an effective stormwater management device.

THE ROLE OF GRASSCRETE

GRASSCRETE porous paving was originally designed as an attractive load bearing surface for car parks, access roads and embankments having the general appearance of grass and the load bearing and anti-erosion characteristics of reinforced concrete. GRASSCRETE has been highly successful not only in the UK but throughout the world in fulfilling this original aim.

It has, however, become increasingly evident that the design capability inherent in the GRASSCRETE system offers significant benefits both in reducing run-off from car parks, contributing to sub-terranean water table re-charge, reducing the rate of evaporation of ground water in hot climates and offering advantages over solid concrete surfaces for flood alleviation and land drainage channels in difficult soil conditions.

Tests undertaken by the College of Architecture and Urban Studies at the Virginia Polytechnic Institute and State University in the USA, have shown that GRASSCRETE installed with soil and grass has, under different levels of rainfall, allowed significant quantities of water to pass through to the ground as it would in normal undeveloped conditions.

Where GRASSCRETE has been used in the UK as a porous pavement either without any filling to the holes or with the infill being in the form of high drainage media, then virtually the whole of any high intensity rainfall is retained within the GRASSCRETE slab with subsequent slow release allowing groundwater recharge.

Where overlaying poorly draining sub-grades, the lag time will be naturally extended until water percolates through to the natural water table. In such instances, a significant reservoir head can be created by installing a combination drainage blanket within the underlying sub-base (see Fig 1).

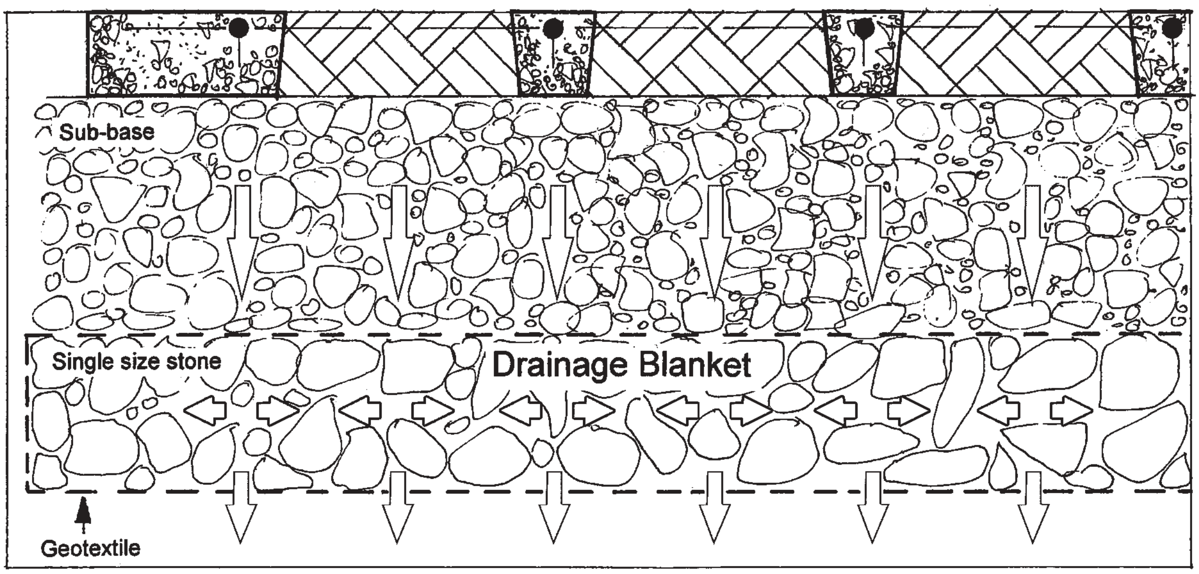

Fig. 1

The advantages of Grasscrete as a drainage slab have been no better demonstrated than on the Isle of Sheppey in the UK. Here, large areas of the system have been constructed to "harden up" storage areas for imported cars. The reclaimed site has a tidally influenced water table which had caused the original loose minestone paving to become a quagmire in winter and a dust bowl in summer. As a consequence, cars were subjected to this dirt and grime which had to be intensively cleaned off prior to the pre-delivery inspection and wax oiling.

To eradicate the problem, GRASSCRETE was laid as a 'total slab' with no infill whatsoever to the pockets. This has enabled the surface to act as a reservoir head where a significant volume of water can be stored within the voids of the 76mm deep paving layer. Since its phased construction through the 1970s and 80s, the pre-delivery process has been transformed.

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With self draining systems, there will be an increased emphasis upon the need to resist differential settlement ('elephant tracking') under load. In this respect, systems identified as precast concrete or the alternative plastic units place a high reliance upon grass cover and rooting to wedge in place and anchor the surface. This tenuous link can be compromised by the combination of seasonal variablity in growth and the intensive wear to the more heavily trafficked areas. GRASSCRETE on the other hand, as the above example proves, places no reliance upon grass for stability. Its' reinforced structure resists differential settlement permitting a safe and sustainable structure.

Whilst this publication has focussed upon the self-draining capabilities of the GRASSCRETE system, it should also be viewed alongside the merits of rebalancing the natural vegetation of former countryside locations.

As a natural "CO_2 eater", the grassed culture helps to reduce "greenhouse" emissions at source within car parks and access roads. Our separate publication "PAVING DESIGN FOR RIVER AND STORMWATER CHANNELS" shows how natural wildlife wetland habitats can be reinstated by the use of GRASSCRETE in flood channel schemes.

With a wealth of experience as an original environmental "innovator", we are happy to assist Architects and Engineers in formulating sustainable project designs.

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