CONCRETE BLOCK PERMEABLE PAVEMENTS

FAQ and additional technical advice

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The Precast Concrete Paving & Kerb Association
The Old Rectory, Main Street,
Glenfield, Leicester LE3 8DG

tel: 0116 232 5170
fax: 0116 232 5197
e-mail: info@paving.org.uk
website: www.paving.org.uk

Interpave is a Product Association of the British Precast Concrete Federation Ltd.

Introduction
Concrete Block Permeable Pavements (CBPPs) have been in use in the UK for over 15 years, and longer in other parts of Europe. Comprehensive design and construction guidance is available – notably Interpave's *Guide to the Design, Construction and Maintenance of Concrete Block Permeable Pavements*: Edition 3 – and extensive research into performance has been carried out.

Today we are seeing a rapid growth in popularity of this technology and a wider range of applications where it is used, fuelled by national planning guidance, Building Regulations and other pressures for more sustainable solutions. As a result, new issues are being raised. Pavement designers need to take an holistic approach and assess how CBPPs fit into existing street regimes – dealing with issues such as construction, maintenance, adoption and service corridors – and, where necessary, take a fresh sustainable approach.

This document aims to address issues effecting CBPPs today, enabling designers to make wider use of the technology with confidence. The answers provided reflect best current practice, pooling information from a number of experts and documented research - although further research continues.

Question: The HR Wallingford/CIRIA publication *Drainage of Development sites - a guide X108* notes that there maybe some significant potential problems with permeable paving (eg Table 8.1 on page 69 notes that there is no proven long-term reliability, no established design criteria and additional comments on pages 184/185). Is this still true.

Answer: This document was originally published in 2002 as HR Wallingford Report SR 574, and was re-issued by CIRIA in 2004 without any significant technical amendment or review. Since then there have been significant developments in the design and construction of CBPPs based upon practical experience both in the UK and worldwide.

There are now established design criteria for CBPPs such as the Interpave guidance - *Guide to the design construction and maintenance of concrete block permeable pavements* (Edition 3, 2005). This reflects both UK and worldwide experience. This guide is currently being expanded to address the questions raised in this document plus provide additional design assistance.

CIRIA and HR Wallingford are currently producing a comprehensive Design, Construct and Maintenance Manual that covers all types of SUDs systems including Permeable Pavements (CIRIA Report C697). Interpave has assisted in the preparation of this document - in particular the section on Permeable Pavements. It is understood that this document will be available in late 2006 and with regard to CBPPs it will provide similar advice to the Interpave document.

It should also be noted that in the next few years the application of the Water Framework Directive will become increasingly notable. The environmental liability of

normal piped drainage should be considered against the much reduced risk associated with permeable pavements in this respect.

There are some local authorities (eg South Oxfordshire, Northampton) that have adopted permeable pavements.

Question: Information to date appears to state that generally CBPPs are limited to car parking areas due to the reduced loading capabilities of waterlogged sub-base materials. Is this changing

Answer: This is not true. The latest CIRIA Design manual for SUDS (to be published later this year) should remove this misconception. CBPPs have been used in highly trafficked and highly loaded areas such as port container yards, airport fire training grounds and supermarket delivery access roads.

The key issue is that the design allows for water in the sub-base and the sub base materials. In addition, if water is to be allowed to infiltrated into the sub grade this also has to be allowed for.

All the research available indicates that concrete blocks used in CBPPs themselves have the same structural performance as normal blocks and are manufactured to the same British/European Standard as conventional block paving.

The open graded aggregates used in the permeable pavements will be slightly less stiff than Type 1 sub-base, but if the hardness and durability are correctly specified (Los Angeles and Micro Deval specification) then the presence of water will have limited effect on its performance. The material used is not like Type 1 which needs to be kept dry because it performs poorly in a structural capacity when wet because of its fines content. The draft version of *Design Manual for Roads and Bridges, Volume 7, Section 2,Part 2, DraftHD25/06, Foundations, Highways Agency, 2006* indicates that open graded sub base Type 3 has a stiffness of 130Mpa which is not that much lower than the value given for Type 1.

It should be possible to measure the stiffness of the open sub-base and undertake a multi layered elastic analysis under a load, as specified in HD25/06 to determine the foundation class to allow the overlying asphalt or block layers to be designed. Consultants EPG Ltd, have undertaken this recently using finite element analysis and found that it is possible to design the sub-base to give class 1 or 2 foundation conditions.

With respect to the bearing capacity of the soil subgrade when wet, there are a number of solutions ranging from total infiltration to no infiltration of water into the sub-grade (Systems A, B and C). It is important to understand that because the sub base is free draining it is likely to be saturated for relatively short periods of time, and probably for less time, unlike a conventional impervious pavement where cracks in the surface allow water into the structure that cannot easily escape. Steve Wilson of

EPG comments "My own feeling is that I think that these systems are actually better drained than normal road pavements and will be dryer for a greater proportion of time than conventional pavements. The key issue for pavement life is good drainage and these systems have that."

Question: Can the design life be in excess of 10 years.

Answer: Yes. Experience and evidence demonstrates that the design life can be the same as conventional pavements **IF** the materials and design take account of water being present. This is also based on an assumption that the surface clogs and reduces infiltration. Structurally there is no reason why they cannot be designed to a 20 or 25 year design life in the same way as normal road pavements. The key is the correct specification of materials.

Question: What happens if the joints clog.

Answer: Even if there is no maintenance it is unlikely that the whole pavement surface will become impervious. CBPP can become clogged but there are some key issues that influence the extent of clogging – Hydraulic design, landscape design, construction practice and maintenance.

Hydraulic design - Is based upon the assumption that the joints will clog and will reduce the percolation of water through the joints to only 10%. (See page 12 of the Interpave guidance).

Landscape Design - The landscaping needs to be designed to avoid mud and debris falling towards the pavement or alternatively a buffer zone provided at the toe of slopes to avoid mud and other detritus flowing onto the pavement.

Construction - During construction care must be taken to ensure that the pavement is not contaminated with general construction mud and other materials. A technique to avoid problems is to form a temporary impermeable access road with asphalt laid over the top of the permeable sub-base. This surface remains in place permanently, but prior to the laying of the block layer, the asphalt surface is cleaned and sufficient holes are punched or cored through the asphalt so water can flow into the sub base. It will be necessary to deal with surface water prior to converting this pavement into a permeable pavement. An alternative approach is to construct a conventional sub base to be used as a construction platform or temporary pavement but prior to the completion of the project, a System C CBPP is constructed on top of the conventional sub base.

Maintenance - Experience has shown that ideally the maintenance of permeable pavements should be undertaken two to four times a year.

This will maximise the infiltration, but as discussed above the designs allow for clogging. A sweeper with a jet wash and suction seems to be the best method of cleaning but care and adjustment of the cleaning equipment must be taken to ensure the jointing material is not removed from the joints.

Maintainace of CBPPs is no more onerous than the requirements for conventional pavements that should have gullies to be cleaned out on a regular basis.

Recently EPG Ltd undertook some permeameter testing on a permeable pavement that had joints that appeared to be blocked with vegetation and detritus. The surface water flowed away from the clogged areas and into other areas despite the condition of the joints. Minor ponding occurred on the surface but it is far less than would be expected on an impermeable surface.

Question: There is little information on the hydraulic characteristics (inflow, outflow, losses) from pavements with sub-base storage. How can the design still be undertaken.

Answer: This is really only an issue for those who are immersed in drainage research! In practice, enough is known about how permeable pavements perform to be able to design them. The issue referred to would allow the design process to be refined to make it less conservative than it currently is.

Question: It has been stated that the poor performance of CBPPs and other infiltration methods is often attributed to defects in the design, poor construction techniques, low-permeability sub soils and lack of adequate preventative maintenance.

Answer: This is true! It is also true that any other civil engineering structure that has a defective design, poor construction and lack of maintenance, will also have poor performance. A correctly designed pavement for different parameters and soil conditions, constructed correctly in accordance with good construction practise will have a long life span and be able to carry the required traffic loads.

Question: Is an overflow pipe required even for a total infiltration system (System A) to prevent flooding or frost heave.

Answer: Many total infiltration systems have been designed without an overflow pipe, including on clay sub grades, with no other outflow. Any surface flooding in extreme events is only a rare occurrence and will in any event only be present for a few hours. This has generally found not to be an issue and is no different to normal drainage which will flood out of manholes if the design rainfall is exceeded.

Frost heave does not occur if the pavement is designed correctly. If the pavement is full and prolonged freezing does occur (an extremely unlikely combination as the pavements are designed to drain down quickly) then ice mushrooms may appear at the surface in the joints between the blocks as the water expands in the pore spaces between the aggregate. The only record of this happening is in the Midwest of the USA where the winter climate is far more severe than the UK. It should not be an issue in a correctly designed pavement.

Question: Is it recommended that where possible, permeable pavements should be constructed only after all major earth-moving and landscaping on site have been completed to minimise contamination and sealing of the surface. The surface can be protected by covering with geotextiles if necessary.

Answer: Yes. Permeable pavements are different and the construction process needs to take account of this. This may mean that some areas are not suitable (for example if the road needs to be used for construction access).

Question: Should the pavement should be inspected several times in the first few months, followed by regular annual maintenance

Answer: Yes – this is the same as the recommendations for any drainage system.

Question: Do I use a dry or a soaked CBR value for the design

Answer: The design should always be based on a soaked CBR value.

Question: Are there special requirements when accommodating utility services.

Answer: Permeable pavement design needs to interact with service design and it may be necessary to develop a different service design philosophy. For example, it would be desirable to put services in specific corridors such as conventional impermeable footways away from permeable pavements. This is particularly important when using no infiltration systems (System C), that relies on an impermeable membrane to hold water within the pavement.

A technique to achieve service crossings, is to create small sections of conventional impermeable pavements within the scheme, perhaps used as pedestrian crossings, other traffic safety devices or aesthetic features, that accommodate services.

Question: The Interpave guidance states that permeable pavements can be constructed with a zero gradient. How does the water drain from these pavements.

Answer: The subgrade will need to be designed with gradients to ensure drainage of the sub-base material and to prevent ponding within the sub base.

Question: Can permeable pavements be used on steep sites.

Answer: Yes, but it may be necessary to construct dams or baffles within the sub base to restrict the flow of water otherwise the water within the sub base may discharge through the block surface at a lower level.