

Question: Why should I consider using a permeable pavement?

Answer: Planning for climate change is today a major driver for construction and the built environment. Environment Agency research following the flooding events in 2007 showed that approximately 66% of flooding was caused by surface water runoff.

The UK climate appears to be getting warmer and wetter and much of the existing drainage network is at near or full capacity. This means that it can't cope with the additional volumes of surface water drainage generated by new development, resulting in a significantly increased flood risk.

To address these issues the Government passed The Flood and Water Management Act (2010) that applies to England and Wales. This Act takes forward some of the proposals in previous strategy documents published by the Government and replaces existing drainage regimes with a Sustainable Drainage System (SuDs) regime.

Permeable pavements are seen as offering a cost effective method of attenuating and filtering surface water and satisfying the SuDs philosophy.

Question: How does a permeable pavement work?

Answer: Permeable pavements work by replicating the drainage patterns of an undeveloped site where up to 95% of rainfall is absorbed into the land with only 5% becoming surface water runoff. In this way the flow is attenuated, removing the early spike in surface water runoff and relieving pressure on the system downstream.

Depending upon site conditions it may be possible to allow the captured water to slowly infiltrate into the ground or discharge into the next stage of the management train. The typical flow rate of water leaving a permeable pavement is 2 to 7 l/s/ha (litres/second/hectare). Both these methods serve to significantly reduce the risk from surface water runoff especially when tied into a wider flood planning strategy.

Question: How does using a permeable pavement improve water quality?

Answer: Research by the Construction Industry Research and Information Association (CIRIA) has shown that a permeable pavement can remove 60 – 95% of suspended solids and 70 – 90% of hydrocarbons. The result of this is that the water infiltrating into the ground, or draining into the next stage of the management train, is significantly higher quality than if using an impermeable surface coupled to attenuation tanks.

Question: Does the Flood and Water Management Act (2010) cover permeable pavements?

Answer: Yes. Permeable pavements are seen as a vital component within a Sustainable Drainage System (SuDs) Management Train – this forms a key component of the future strategy for water management within the UK.

In the future it will be a mandatory requirement for surface water management to be taken into account at the design stage and there is no longer an automatic right of connection to the main sewer. Developments will need to comply with proposed National Standards which will be policed by SuDs Approval Bodies (SAB's). This engagement with the local authorities is a key point in gaining adoption of permeable pavements.

Question: Can I gain any benefits from using permeable pavement under the Code for Sustainable Homes (CFSH)?

Answer: Yes. Using Permeable pavements in a housing development can gain credits as follows:

Category 4: Surface Water Run off

- 1 credit because there is no run off from the first 5mm of rainfall (see Interpave guidance for justification)
- 1 credit for improving the water quality
- 2 credits are available if flood risk is reduced. This includes a range of criteria, including the implementation of SuDs and permeable pavements

Category 8: Management (Home User Guide)

Up to 3 credits are available for the provision of a 'Home User Guide' for a large range of criteria, including details of SuDs within the property boundary, overview of reasons, benefits and advice on maintenance and operation

Question: Can I gain any benefits from using permeable pavement under Building Research Establishment Environmental Assessment Method (BREEAM)?

Answer: Yes. The CfSH formula is to be adopted in commercial/domestic buildings. In this respect BREEAM should really be seen as the Code for Sustainable Buildings. As such, permeable pavements should be seen as an important feature of non-domestic developments where the paved areas and subsequent risk of flooding as a result of climate change is a major consideration.

Question: Are there any other reasons why I should look at using permeable pavements?

Answer: Yes! In addition to making a more pleasant environment, research has shown that removing the risk of standing surface water makes our streets safer as vehicles are less likely to aquaplane. This comes on top of the 2.5 – 4.5 mph reduction in traffic speeds noted in the Manual for Streets which means that, in addition to enhancing the aesthetics of our urban areas, permeable pavements can also help to significantly increase safety and comfort for all road users.

Question: It appears permeable pavements are limited to car parking areas as there is little design information to support other applications. Is this true?

Answer: No. There are established design guidance documents for a wide range of applications from car parks to lorry parks/ bus terminals (up to 15msa). More details can be found in the Interpave guidance *Guide to the design construction and maintenance of concrete block permeable pavements* (Edition 6 2009) and British Standard document BS7533-13:2009 *Pavements constructed with clay, natural stone or concrete paving blocks and flags, natural stone slabs and setts and clay pavers*.

Permeable pavements can also be used in highly trafficked and highly loaded areas such as container ports. Information in designing for these applications is contained in an Interpave document *Heavy Duty Pavements – The Structural Guide of Heavy Duty Pavements for Ports and Other Industries* (Edition 4, 2007)

Brett Landscaping and Building Products have developed **PermCalc** – an on-line software tool for designing cost effective permeable pavements www.permcalc.co.uk

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

Answer: Yes. There is no reason why they cannot be designed to a 20 or 25 year, or even longer design life, in the same way as normal road pavements are. The structural design methodology is based upon predicting the number of Million Standard Axles (msa's) which the pavement is expected to endure over its design life.

Question: What are the maintenance implications to ensure that the permeable paving performs at its design level?

Answer: Even if there is no maintenance it is unlikely that the whole pavement surface will become impervious. The Interpave, British Standard and PermCalc methodologies are based upon an initial infiltration rate of 4000 mm/hour through the paving surface but in the design procedure this is reduced by 90% to 400 mm/hour to allow for significant clogging of joints.

Question: Are there any special requirements regarding adjacent landscape areas?

Answer: Yes. It is good practice to ensure that any adjacent landscaped areas are designed to avoid mud and debris being washed and/or deposited on the pavement. This may necessitate the creation of a buffer zone at the toe of the slopes to avoid mud and other detritus washing onto the pavement.

Question: Can a permeable pavement be trafficked during the construction process or used to provide temporary access, as the current practice for constructing housing projects?

Answer: No – not without special precautions. During the construction process care must be taken to ensure that the pavement is not contaminated with general construction mud and other detritus. If there is a need to use the road for temporary access then the permeable sub-base can be overlaid with Dense Bitumen Macadam (DBM) to form a temporary site running surface.

The DBM surface remains in place permanently, but prior to the installation of the block layer, the DBM surface is cleaned and sufficient holes are punched or cored through it to allow water to flow into the sub-base. It is recommended to provide 75 mm diameter holes on a 750 mm orthogonal grid. The DBM thickness required and any compensation for a reduction in the hydraulic storage capacity must be taken into account in the design process.

It will be necessary to provide a temporary surface water management solution to deal with surface water runoff prior to converting the pavement into a permeable pavement.

Question: What maintenance is required?

Answer: Very little. The maintenance of permeable pavements is different to conventional pavements but is no more onerous than the requirements for conventional pavements which should have their oil interceptors maintained and their gullies cleaned out on a regular basis.

It is advisable to ensure that the joints remain full with suitable jointing aggregate. If there is any ongoing evidence of water ponding on the surface this will indicate that the joints have become impervious. If a site investigation proves this to be the case and it is considered that this is significantly impeding the hydraulic performance of the pavement then remedial action should be undertaken.

A sweeper with a jet wash and suction provides the best method of cleaning and removing detritus from the joints. If it is necessary to remove some or all the jointing aggregate then the aggregate should be replaced with suitable new aggregate.

Question: There is little information on the hydraulic characteristics (inflow, outflow, losses) from permeable pavements. How can the design still be undertaken?

Answer: This is really only an issue for those who are immersed in drainage research! There is enough design guidance, such guidance produced by Interpave – The Precast Concrete Paving and Kerb Association and the British Standards Institute.

Question: It has been stated that the poor performance of some permeable pavements is attributable to defects in the design, poor construction techniques, low permeability sub soils or lack of adequate preventative maintenance. Is this true?

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 using the appropriate design parameters and soil conditions, built in accordance with good construction practice will have a long life-span and be able to carry the required traffic loads without distress.

Question: What happens if the water in the sub-base freezes?

Answer: A permeable pavement acts as an insulator so the depth of frost penetration is low. Extensive research undertaken by Fergusson in the US and North America investigating all types of permeable pavements demonstrates that they are not adversely affected in cold climates.

Question: Do I need to consider the effects of frost heave?

Answer: Frost heave does not occur if the permeable pavement is designed correctly given the high void space in the sub-base. If the pavement is full of water and prolonged freezing does occur (an extremely unlikely combination in a temperate climate as the pavements are designed to drain quickly, typically within 24 – 48 hours) then ice mushrooms may appear at the surface in the joints between the blocks as the water expands in the pore spaces between the aggregates. The only record of this happening is in Mid Western USA where the winter climate is far more severe than in the UK. It should not be an issue in a correctly designed pavement in the more temperate UK climate.

Question: Should the pavement 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 systems.

Question: What California Bearing Ratio (CBR) value should be used for the design?

Answer: The design CBR should be the lowest value which the subgrade can be expected to reach during the life of the pavement. This will vary depending upon the pavement drainage requirements:

In the case of System A, total infiltration or System B, partial infiltration where the water drains into the sub grade, then the soaked CBR value should be used. In the case of System C, no infiltration or tanked system, where water is contained within the pavement and does not percolate into the sub grade, this will normally be the Equilibrium Suction Index.

Question: Are permeable pavements needed in all of the trafficked areas of the development?

Answer: No. It is not necessary to design all the surface areas as permeable, as permeable pavements may have spare hydraulic storage capacity that can cope with run-off from adjacent impermeable surfaces including roofs.

It is normal practise to limit a ratio of impermeable to permeable area to about a ratio of 2:1. Ratio's greater than 2:1 usually result in the permeable sub-base thickness becoming excessive and not cost-effective. Also, silt loads flowing onto the permeable pavement become excessive at ratios greater than this which significantly increases the risk of clogging.

Question: How do we deal with the maintenance of services and utilities within a permeable pavement?

Answer: Ideally sites should be planned to avoid the need for placing services underneath, or within, a permeable pavement.

Utilising the 2:1 rule and with appropriate layout design, services and utilities can be located within conventional impermeably paved areas creating service corridors or verges. These remove the need to accommodate the services within or under the permeable paved areas thereby avoiding any service excavations into, or through, a permeable pavement.

This approach can also form a key part of the overall design both visually and technically allowing designers to use their imaginations and realise the aspirations of Manual for Street 1 & 2.

PermCalc software identifies spare hydraulic capacity. This assists the designer in making informed decisions on locating services outside of the permeable areas.

Question: What is the cost of a permeable pavement and is it more expensive than conventional pavements?

Answer: There is no simple answer. Generally the initial construction costs of a permeable pavement are comparable with conventional pavements. The sub-base may be thicker and more expensive than conventional pavements but is balanced out by reduced ground works and negating the need for items such as gullies, connections and oil interceptors. Interpave has demonstrated that the Whole Life Costs of a permeable pavement in many cases provide a more cost effective solution. See www.paving.org.uk

For a particular project the only accurate method to quantify costs is to undertake a design and then cost this design. Brett has developed PermCalc, design software which uses the British Standard methodology as a basis for generating costed design suggestions. Therefore provides the capability to quickly run various 'what if' calculations to fully assess the cost implications based upon default construction rates or the client's construction rates.

PermCalc is available at www.paving.co.uk

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

Answer: There should be no standing water on the surface as water drains immediately into the pavement. For System C pavement, the subgrade will need to be designed with gradients to ensure drainage of the sub-base aggregate and to prevent ponding within the sub-base.

However, in reality there will be virtually no zero gradient sites as most sites are designed with a gradient for fit with the topography.

Question: Can permeable pavements be used on steep sites?

Answer: Yes, but it may be necessary to increase the sub-base depth to compensate for the loss of storage capacity due to the slope or 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.

PermCalc automatically checks and increases the sub-base depth up to an arbitrary limit and if there is still insufficient hydraulic storage capacity, will introduce internal dams and determine the spacing of these dams. See www.permcalc.co.uk

Question: Is it possible to use fill material under a permeable pavement?

Answer: Yes, if filling is required to build up levels, then the fill material must have similar or superior properties to the existing subgrade after the completion of the filling operation.

For System A & B pavements, in addition to above requirement, the permeability must similar or superior and the fill material unaffected by the ingress of water.

Consideration must be given if it is proposed to use crushed concrete in System A or System B pavements as fill material. After water has infiltrated through the crushed concrete is it is likely that it will have an elevated alkalinity. This may not be desirable or be allowed to infiltrate into the sub grade or be discharged from the site.