Impermeable surfaces such as parking areas, paved roads and footpaths are often cited as one of the major causes of storm water run-off. Water from rainstorms quickly flows off these surfaces into storm drains and waterways. Balancing ponds are often used to collect and attenuate the rate of run-off from these surfaces, but while balancing ponds are effective, they often occupy expensive land which could be built on.

Changing land use from ‘rural’ to urban increases flood risk. Developing a site with hard-paved areas and roofs prevents the natural dissipation of rainwater and increases both the rate and the volume of run-off water. The adverse effects of inappropriate development are cumulative and can lead to significant problems in the longer term. Planning Permission Guidance Note 25 (DTLR) suggests that Sustainable Urban Drainage Systems (SUDS), which mimic the natural processes of recycling rainwater back to the air and ground, should be implemented. The Environment Agency (EA) is empowered by government to advise planning authorities working on development and flood risk matters to use their powers to guide developments away from areas that may be affected by flooding and to restrict development that would increase the risk of flooding.

The EA is now actively encouraging local authorities to include porous pavements in supplementary planning guidance on SUDS. House builders are also being encouraged by the EA to adopt SUDS porous pavements. The local authorities know there is a presumption in favour of using SUDS and the legislative/regulatory framework is changing to make it more difficult to use conventional drainage design. However, the water supply companies will not adopt drainage pavements as part of a sewer system as ownership rests with the local authority or property developer on the same basis as conventional paving as an integral part of the construction. The outfall from a porous pavement SUDS system could be a swale which the local authority would adopt.

A full-depth permeable pavement (drainage pavement) that allows surface water to infiltrate into the sub-grade or to be captured for controlled release off site, offers a SUDS solution for flood-water management. With proper design and installation, a drainage pavement can provide a cost-effective solution with a proven lifespan of 20 years or more, and at the same time provide a storm-water management system that promotes infiltration, improves water quality and eliminates the need for balancing ponds.

The concept
Rain water percolates through the asphalt or concrete surfacing into a porous sub-base material. Here, water from sudden downpours accumulates (like a reservoir) before it is dissipated more slowly into the subsoil or removed through drains into the main surface-water drainage system. This process helps to relieve storm-water surges and reduces the risk of flooding as a result of the drainage system becoming overloaded.

The main function of balancing ponds can be provided by reservoirs or natural aquifers formed in the pavement using porous materials. These reservoirs can be located in the paving structure of parking areas, lightly trafficked roads, sporting facilities, housing estates, school playgrounds, footpaths etc. The load on surface-water sewers can also be reduced by diverting water into the reservoir layer of these pavements. They also help to reduce traffic noise and filter out pollutants in rainwater.
Historical developments

Research towards better management of the environment and natural resources has been carried out sporadically in the US since the 1950s. In the late 1960s the concept of a full-depth porous pavement was proposed to promote infiltration, reduce loads on surface-water drainage systems, reduce flood risk and raise water tables. The first scientific trials of porous pavements were carried out in Pennsylvania and Texas in 1977. This resulted in the production of a design guide which formed a solid basis for subsequent developments. Since then an ever-increasing number of porous pavements have been constructed in the US and this interest has culminated in the recent introduction of a design guide.

Development of drainage pavements is more advanced in France where they are known as reservoir pavements, by virtue of a thick granular gap-graded sub-base to temporarily store water from heavy rain. In France, the driving force behind these pavements is urbanization, which results in an overall reduction in the permeability of the ground. For example, in Bordeaux over 300 drainage pavement schemes have been implemented since heavy rainfall in 1982 threatened further development. The proven durability of these pavements in low-traffic sites has led to their widespread adoption throughout France.

Application in the UK

In the UK the role of permeable asphalt paving within SUDS can be appreciated from a CIRIA publication in which drainage pavements, along with good site management, are listed among four general methods of control. The car park of the B&Q retail outlet in Portsmouth, constructed by Tarmac in 2002, is a good example of drainage pavement implementation. The car park was constructed on a flat site that is only a few metres above sea level. This posed difficulties in the provision of an effective run-off gradient for the outflow drainage system. The construction of the car park embraced the objectives of SUDS and avoided difficulties in designing a full-capacity outflow drainage system in a very flat, low-lying area where water would have to flow a considerable distance before emptying into the sea. This resulted in reduced costs for the outflow system. It also ensured the absence of standing water in the car park; this is important for a retail outlet car park, where customer safety and comfort are paramount.

The construction consisted of a fully flexible pavement consisting of a composite layer of porous asphalt laid on a granular sub-base layer of crushed concrete. The hydraulic performance of each porous asphalt layer was checked by Tarmac to assess compliance before laying the next layer. This specialized construction was carried out using a tracked paving machine to minimize disruption to the gap-graded granular sub-base. The confinement effect of the overburden of the asphalt layer ensured that the sub-base performed in a similar way to conventional sub-base when in service.

TRL were commissioned by Tarmac to assess the pavement condition using a falling-weight deflectograph (FWD) prior to the official opening. The results showed that there was consistency throughout the site in terms of both stiffness and deflection, and the structure was considered suitable for the purpose that it was designed for. Because positive drainage is not necessary, savings in the cost of site drainage more than offset the higher material costs incurred during construction.

Tarmac have been developing porous pavement technology in the UK since 1997 and are able to offer a bespoke design, build and maintain service backed by guarantees. The company have also completed a number of contracts during this time, implementing several key technological improvements and building on overseas experiences to facilitate improved performance and, in particular, to ensure the pavement design life is maximized. The use of special polymer-modified asphalts and other additives are key to delivering a long-life drainage pavement. Maintenance of hydraulic conductivity is another important aspect which Tarmac are well placed to advise on following extensive research into this area.

Benefits

Drainage pavements fit within the requirements of SUDS and help to achieve sustainable construction targets with benefits to the environment. As well as reducing or eliminating storm-water run-off and flood risks, they help to recharge groundwater levels. They also reduce the need for kerbing, surface-water sewers and balancing ponds, which can tie up expensive land. They can be used as soakaways to deal with run-off from roofs and other paved areas.

In addition to removing pollutants from run-off water, safety and user comfort is improved by the reduction in noise, spray, glare, standing water and the formation of surface ice in winter.

In terms of construction cost, drainage pavements offer significant cost savings compared to conventional pavements that incorporate positive drainage, and they also offer a more environmentally sustainable solution.

References