Water Sensitive Urban Design

POROUS PAVEMENT

Purpose of this fact sheet:

This fact sheet provides advice to the development industry on using porous pavement as part of a Water Sensitive Urban Design Strategy in the Coastal Dry Tropics Region.

Porous Pavement

Porous pavements are an alternative to typical impermeable pavements and are available in several commercially available forms (Figure 1). They can be made of porous material (porous 'no fines' concrete, pervious/open-graded asphalt or porous pavement), made of a modular lattice structure (plastic or concrete) or constructed so that there is a gap in between each paver. Porous pavements provide a more aesthetically pleasing surface compared to conventional asphalt/concrete pavements. Porous pavements, as their name implies, are a pavement type that promote infiltration, either to the soil below, or to a dedicated water storage reservoir below it.

Figure 1 - pavers in Manly Residential, grass pave and a porous car park road gutter (Manly).

Treatment process

Permeable pavement removes some sediments and attached pollutants by infiltration through an underlying sand/gravel media layer. They also reduce runoff volumes by infiltration to the sub-soils and delay runoff peaks by providing retention/detention storage capacity and reducing flow velocities.

Porous pavements can be designed as infiltration systems or detention systems. Infiltration (or retention) pavements temporarily hold surface water for a sufficient period to allow percolation into the underlying soils. Detention pavements hold surface water temporarily (short period) to reduce peak flows and later releasing into the stormwater system.

KEY POINTS OF THIS FACT SHEET

This fact sheet provides advice to professionals in the development industry with:

- An overview of porous pavement and their applicability as part of the WSUD treatment process
- Opportunities and site constraints
- Design, construction and maintenance issues

City of Townsville

Incorporation of Porous Pavement in WSUD Design

Porous pavement can be incorporated into WSUD strategy designs in a range of circumstances as long as a number of key design considerations are addressed.

Optimal operating range (catchment area, target pollutants)

Porous pavements are most practical and cost effective when applied to catchment areas between 0.1 and 0.4 ha and are most effective in removing coarse to medium sized sediments and attached pollutants (such as nutrients, free oils/grease and metals). They also reduce the impervious area of a catchment and because of their ability to provide an initial rainfall loss, runoff from porous pavement is less likely to have the often observed 'first-flush' effect, where greatly elevated pollutant concentrations are observed in the first part of a storm (Fletcher et al. 2003).

Site Selection and Retrofit Opportunities

Porous pavements are best suited to catchments with low sediment loads and light vehicle weight such as small car parks (Figure 2), low traffic streets (e.g. cul-de-sacs) and for paving within residential and commercial developments. Applicable surface grades are those of 1% to 5%. Site limitations that may preclude the use of this WSUD measure include areas with high traffic volumes or weights, catchments with significant sediment loads, terrain with loose sands or heavy clays, exposed bedrock or shallow soils, steep topography (>5%), high water tables, potential salinity hazard areas or on non-engineered fill or contaminated land. In high traffic areas the loads of pollutants can significantly decrease the ability to remain porous. Porous paving has been successfully retrofitted into the Sydney suburb of Manly, where small residential street, pathways and car parks were retrofitted with porous pavers or porous concrete.

Position and role in a stormwater quality improvement 'treatment train'

Porous pavements are applied as a means of reducing impervious area and hence providing flow attenuation. They are not generally used in a stormwater quality improvement treatment train but function parallel to treatment trains by reducing runoff volumes. They are not designed to treat stormwater runoff from adjoining impervious and pervious surfaces. Overflow from porous pavement can however be directed into other WSUD elements for treatment if feasible.

Figure 2 - Porous Pavement in car park, Washington DC

Figure 3 - Close up of porous pavers being laid

Design, construction and maintenance

Typical design issues (including designing to overcome site constraints)

Porous pavements are permeable pavement with an underlying storage reservoir filled with aggregate material. Modular block pavements (including lattice block pavements) or permeable pavements overlie a shallow storage layer (typically 300 mm - 500 mm deep) of aggregate material that provides temporary storage of water prior to infiltration into the underlying soils. Design should ensure that the required traffic load can be carried. Pavers that are porous from the use of gaps between individual pavers should be carefully chosen with reference to likely catchment inputs, such as leaves and debris that can quickly block the gaps. It is recommended that the invert of the system (underlying storage layer) should be at least 1 m above impermeable soil layers or seasonal high water tables. Allowance for a 50% reduction in design capacity over a 20 year life span should also be made during design (Fletcher et al. 2003).

Typical construction issues

Porous pavements are usually laid on sand or fine gravel (Figure 3), underlain by a layer of geotextile, with a layer of coarse aggregate below. Pavement areas should not be used for sediment control during construction and pavements should not be laid until all catchment surface areas have been stabilised to prevent sedimentation and consequent premature clogging and blockage of porous material. Where porous paving is to provide infiltration, construction areas should be fenced off to prevent heavy equipment compacting the underlying soils. The pavement subgrade should also be ripped/tyned before placement of the overlying aggregate of topsoil.

Along with evidence of many successful implementations of porous pavements, there are many instances of failure, because of clogging. It is absolutely critical that porous pavements are protected from large sediment loads during and shortly after the construction phase. Failure to do so could see the effective life span of the pavement reduced (Fletcher et al. 2003).

Maintenance advice

Maintenance activities vary depending on the type of porous pavement. In general, porous pavement should be inspected for cracks and holes, and removal of accumulated debris and sediment should be undertaken every three to six months. Depending on the design of lattice pavements, weeding or grass mowing may need to be undertaken. If properly maintained, and protected from 'shock' sediment loads, porous pavements should have an effective life of at least 20 years (Bond et al, 1999; Pratt, 1999; Schluter et al, 2002 as cited in Fletcher et al, 2003).

Key references

References to design guides, proprietary devices and suppliers

Fletcher, T.D., Duncan, H.P., Poelsma, P. and Lloyd, S. (2003) Stormwater Flow and Quality and the Effectiveness of Non-Proprietary Stormwater Treatment Measures; A review and Gap Analysis, The Institute for Sustainable Water Resources, Monash University and the CRC for Catchment Hydrology.