3.15 Porous Pavements (BMP I2)

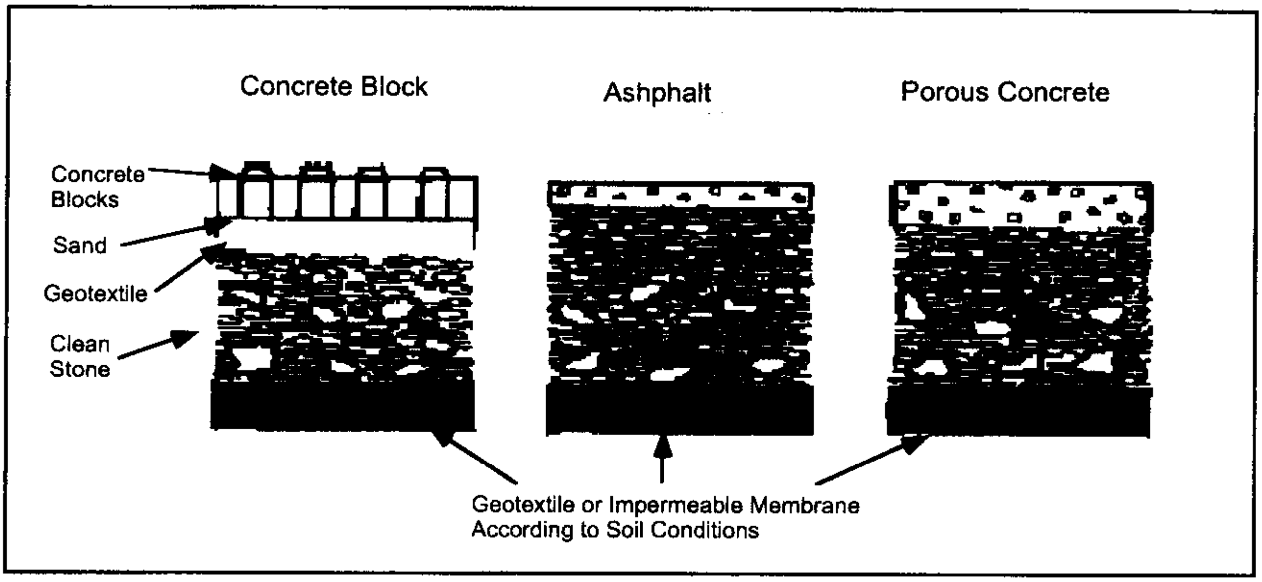

Figure 3.15.1: Schematic of Porous Pavements

Description

Porous pavements are deep, open-graded asphalt/concrete pavements with much of the fine aggregate material intentionally left out above a gravel layer bedded on a sand filter layer.

Selection Criteria

- Applicable to low runoff volume areas such as low runoff parking areas, for roof runoff on adjacent paved areas, and lightly used roads.
- Most practical and cost-effective for catchments 0.1-4 ha.
- Slope of land to be developed should generally not exceed 5%.
- Preservation of pre-development water balance at site, reducing downstream flows.
- When properly constructed, porous pavement has similar load bearing strength, longevity and maintenance requirements to conventional pavement.

Pollutant Trapping Efficiency

Litter	I	Sediment	M-H	Nutrients	M
Oxygen demanding material	L-M	Oil and Grease	I	Pathogens	L-M

Limitations

- Not recommended where erosion, heavy or high volume traffic is expected to supply large quantities of sediment.
- Not recommended for areas with high wind erosion.
- Applicable where pavement is at least 1 m above bedrock and water table.
- High failure rate due to partial or total clogging.
- Possible risk of groundwater contamination.
- Inappropriate for high traffic areas.

Cost Considerations

- Moderate to high capital cost, moderate to high maintenance costs.
- Inadequate maintenance has been a cause of the high failure rate for these devices.

Additional Information

Porous pavements are deep, open-graded asphalt/concrete pavements with much of the fine aggregate material intentionally left out above a gravel layer bedded on a sand filter layer. Runoff percolates through the asphalt/concrete layer into a gravel storage reservoir.

Porous pavements can be designed in the following ways:

- Runoff collected by the pavement exfiltrates at a relatively slow rate through the base of the pavement into the subsoil.
- Runoff in the pavement is collected by porous pipes and discharges to water cycle infrastructure system.
- A combination of the above.

Each method results in removal of fine particulate and, to some extent, soluble pollutants from stormwater. The first method also results in groundwater recharge and subsequent reduction in runoff volumes. An alternative surface to open-graded asphalt/concrete pavements is modular paving.

Design Guidelines

Permeable soils are essential for the success of infiltration trenches which exfiltrate water to underlying subsoil, ie. minimum percolation rate greater than or equal to 15 mm/hr. Further, the subgrade soil should be able to support design load under saturated conditions.

Areas within large parking lots that are expected to receive moderate or heavy traffic intensity, or that will accommodate heavy trucks, can be conventionally paved and then sloped to drain to an adjacent porous pavement area.

Capacity and Sizing

Pavement capacity will be largely dependent upon the percolation rate of underlying soil (if exfiltration system) or the capacity of the discharge pipes. The pavement can be designed to drain within three days. This allows soils to dry out, and preserves capacity for the next storm. The greater the soil surface area available for exfiltration and pollutant adsorption, the better the pollutant removal performance.

Design steps:

(i) Calculate the design runoff volume (V_r). This is governed by the standards particular to the site concerned.

(ii) Calculate the storage available:

$$V_s = A \times d_1 \times p_1/100 \times A \times d_2 \times p_2/100$$

where: V_s = Available storage in the pavement and subgrade matrix (m^3)

A = Area of the pavement (m^2)

d_1 = Thickness of pavement (m)

d_2 = Thickness of subgrade base if used (m)

p_1 = Percentage pore space or voids in pavement

p_2 = Percentage pore space or voids associated with the subgrade if used.

Need to choose A, d_1 and/or d_2 such that V_s is greater than V_r. The variables d_1 and d_2 may be governed by strength criteria (calculated using pavement design guidelines).

(iii) Calculate storage volume recovery:

$$Q = KiA$$

where: Q = Rate of recovery (m^3/hr)

K = Hydraulic conductivity or percolation rate of soil (m/hr)

i = Hydraulic gradient (usually assumed = 1, conservatively)

A = Area of pavement (m^2)

(iv) Calculate recovery time Td (hr):

$$T_d = Vr / Q$$

Compare T_d to the allowable recovery time (usually 72 hours). For design to be acceptable T_d have to be less than or equal to the allowable recovery time.

Pretreatment

When overland flow drains onto porous pavement, a filter strip can be placed upstream of the pavement.

Construction considerations

To prevent premature clogging, porous pavement should generally not be placed until all of the surface drainage areas contributing to the pavement have been stabilised. During construction, heavy equipment should be kept away from the porous pavement area to prevent compaction of soils and subsequent reduction of infiltration rates. Diversion berms can be placed around the perimeter of the porous pavement to keep runoff and sediment completely away from the site before and during construction.

Excavation of the sub-grade can be performed by earthmoving equipment with tracks or oversized tyres. Normal rubber tyres should be avoided because they compact the subsoil and reduce its infiltration capabilities. After excavation, the bottom and sides of the stone reservoir can be lined with filter fabric to prevent upward piping of underlying soils.

Clean, washed aggregate can be used. After the pavement has been laid, all traffic should be kept out of the porous pavement areas for a minimum of one day.

Maintenance

The following maintenance activities can be undertaken:

- High suction vacuum sweeping and/or high-pressure jet hosing is appropriate to maintain porosity.
- Repair of potholes and cracks.
- Replacement of clogged areas.

Monitoring

Inspections can be undertaken several times in the first few months after construction and every six months thereafter for the following:

- Areas of sediment build up and cloggingpotholes and cracking.

References

NSW EPA (1996), Schueler (1987), Schueler et al (1992), OMEE (1994), Whelans et al (1994), Galli (1992), CIRIA (1992), The Florida Development Manual - A Guide to Sound Land and Water Management - (1993).