Permeable Pavements in Liveable, Sustainable Cities

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Two-thirds of a modern city's constructed area is pavements. The way those pavements are constructed is an opportunity for environmental rehabilitation. The rainwater on pavements is in danger of pollution, because pavements are in contact with the city's trash containers, vehicles, and animals. That water's volume is large, because the large pavement area collects a proportional volume of rainfall. City trees die among pavements underlain by compacted soil with no rooting value. Most of a modern city's environmental problems and potentials are centred on pavements. These are the same pavements that connect and enable the city's economic and civic life.

In a permeable pavement, water moves vertically down through millions of interconnected pores. Compared with old-fashioned impervious pavements, this is a qualitative change in the direction the water moves and the environmental processes it undergoes. Permeable pavements' storm water management performance has been scientifically monitored at scores of locations around the world. It is now conclusively known that properly designed, constructed, and maintained permeable pavements absorb natural rainfall as fast as it falls. Inexpensive vacuuming effectively maintains or restores surface infiltration. Below, water gradually infiltrates into the underlying soil.

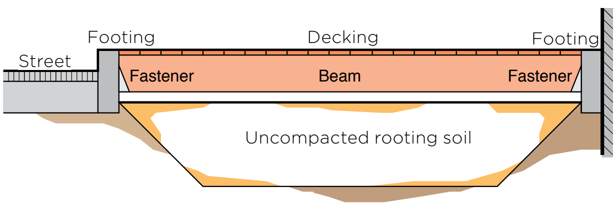
Excess water is detained in the pavement structure, discharging downstream as necessary at controlled rates. Generic urban pollutants are trapped in the pavement structure, so they do not migrate into the environment downstream. Vehicles' oil-based pollutants are biodegraded by naturally occurring microorganisms within the pavement structure, ceasing to exist as water-quality pollutants. Where necessary, swales and basins continue to treat excess runoff downstream.

The treatment, storage, and gradual flow of subsurface water transform potentially destructive pulses of precipitation into a resource for ecosystems and people. In common locations with moderate or seasonal precipitation, infiltration into the subsurface reduces storm flow volumes. The storage of water in subsurface pores sustains evapotranspiration in the local ecosystem. Groundwater is recharged, stream base flow is sustained, pollutants are degraded, and public water supplies are secure.

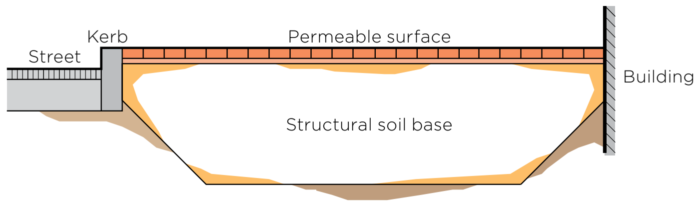
The family of permeable pavements is large; it encompasses a wide variety of materials. The selection of materials changes from project to project, based on the traffic type to be supported, as well as its cost, appearance, and local availability. Pervious concrete and porous asphalt are universally accessible. Permeable pavers (or PICP, which stands for "permeable interlocking concrete pavement") make a "segmental" surface of interlocking units with open joints; various shapes, sizes, and thicknesses are available to suit different traffic, accessibility, and appearance requirements. Unbound aggregate is stable in low-traffic locations such as car parking stalls; in many locales it is the least expensive of all surfacing materials. Turf makes a stable surface in very

1. Permeable decking on a city sidewalk spans over uncompacted rooting soil, freeing trees to grow to full size.

2. In the central courtyard of Sydney's Macquarie University, permeable pavers protect the rooting soil of large shading trees from busy foot traffic.



3 Schematic Construction of Decking, Spanning Over Uncompacted Rooting Soil



4 Schematic Construction of Structural Soil Pavement Base

limited traffic, such as the parking stalls at stadiums and churches; deep sandy rooting soil resists compaction and maintains permeability. For pavements of these materials, their design, installation, and quality control are facilitated by modern standards and installer certifications from authoritative industry associations. We are benefiting now from 40 years of laboratory research, field experience, and industry cooperation. The application of modern permeable pavements is limited only by site-specific physical conditions and the readiness of local personnel to design, install, and maintain them properly.

These environmentally restorative materials, when used intelligently, are able to integrate themselves with urban experiential, social, and economic life. Opening a door to new paving materials and patterns gives designers a new hand to form broadly healthy and attractive civic environments. Although permeable pavements come to attention first for water quality, their intelligent use in urban design contributes widely to private comfort, civic community, and economic vitality.

Urban design employs technology, natural processes, and artistic imagination to create and organise spaces that are sympathetic to the order of city streets and architectural forms. It unifies the parts of a space into a discernible pattern or rhythm with collective clarity and integrity. Where patterns of permeable pavers are aligned with arrangements of kerbs, lights, bollards, and trees, they reinforce the articulation of different spaces and how people are expected to use them. Coloured blocks make quilt-like patterns that define zones for seating, walking, parking, and driving. Panels of tinted, naturally textured, pervious concrete contrast with smooth impervious concrete bands. The patterns reinforce the forms of places and what is important in them. A latent sense of place is made visible.

Where pavement environments allow trees to grow to full size, their canopies shade the ground surface, lowering the temperature, conserving energy in nearby air-conditioned buildings, and reducing the pollutants generated by regional power plants. Their large leaf areas absorb carbon dioxide from the air, emit oxygen, and remove particulates and other urban air pollutants. They bring biodiversity, colour, and structure to the urban space. Their rooting space, from which they draw water for daily transpiration, comes from beneath pavement surfaces; it must be as big in area as the full-grown canopy. Permeable pavements open the subsurface to air and water, activating viable rooting soil. The pavements' base layer is made of structural soil, which holds soil in the void spaces of structural aggregate. Alternatively, decking of lumber, metal grates, or reinforced concrete planks is a permeable surrogate for pavements that span over uncompacted soil, touching the ground only at footings.

The old impervious surfaces sealed landscapes, annihilating absorption. During a storm would come flooding and erosion, with oil and bacteria being flushed into streams; after the storm, there would be no ground water, because water would be flushed away from the watershed when it was available; base flow and aquatic habitats were lost; some communities were left with local water shortages.

In contrast, permeable pavements absorb some or all of the storm water management function into pavement structures that are

5. Mature trees in Brooklyn, New York, grow from the structural soil underlying a permeable aggregate surface.

6. Patterns of permeable paving blocks aligned with kerbs, lights, and trees reinforce spatial definition in an office parking lot.

7. Young trees shading a parking lot will be allowed to grow to full size by the pervious concrete surface, which activates viable rooting soil in the subsurface.

8. In a city park, permeable pavers make a quilt-like pattern, underlain by structural soil supporting rapidly growing trees.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9. In Beijing's Olympic park, panels of tinted, naturally textured, pervious concrete are contrasted with white bands of conventional impervious concrete (Image courtesy of David Mitchell, Bunyan, USA).

10. A parking lane in an old residential street is retrofitted with permeable pavers, reducing CSO pollution while defining the street's spaces and calming traffic.

Opening a door to new paving materials and patterns gives designers a new hand to form broadly healthy and attractive civic environments.

part of economically productive developments. This is a profound contrast with older storm water technologies, which required basins or reservoirs alongside and in addition to the productive construction. Drainage pipes and single-purpose basins wasted urban land added nothing to the life or economy of cities. Although permeable pavements cost more than single-function pavements, it is usual for the overall development to cost less, because permeable pavements absorb both the functions of pavement structure and storm water management in a single structure.

Where permeable pavements are given full credit for their storm water performance, they have profound effects on development patterns and urban economics. Since buildable urban land need not be given away to single-purpose basins, formerly passed-over properties are released for infill development. “Footprints” of productive buildings are allowed to expand, making development and redevelopment economically more feasible and attractive. The number of residential units in development sites increases, up to the jurisdictions’ regulated density. The full productive use of urban land is consistent with today’s urban vision of dense town centres that support public transportation and mutually supporting land uses. At the same time, within these development sites, there is more pervious cover than there would have been with impervious pavements, with all the accompanying implications that they would have for the environment.

Retrofitting even the parking lanes of old and uniformly impervious streets replaces the obsolete surfaces of the past with the dual-function technology of today. Diverting runoff away from old combined sewers reduces Combined Server Overflow (CSO) pollution. Retrofit application is very important to large-scale environmental improvement, because most of the world’s impervious surfaces have already been built: each year’s construction of new pavements makes only a small incremental addition.

Permeable pavements make a city more open, dynamic, and multi-functional. They unify human and natural realms into a single, mutually supportive system. In this kind of development and redevelopment, there is a living tree canopy above, a living rooting zone below, storm water absorption and treatment through the pavement, and the busy city’s traffic across its surface. Participation in natural processes is a relatively new concept for cities. In the past, these processes were considered sacrifices of local environment for human welfare. With today’s technology, no concessions from either the city or its environment are necessary; there is no dichotomy of city and nature to be healed. Mankind need not be seen as a predator of nature, or an urban construction sacrificer of natural processes. The economy, human community, and environment can thrive together, in the same dense, urban place. CG

References:

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