Permeable Paving: The International Scene

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Interlocking Concrete Pavements

Interlocking Concrete Block Pavement (ICBP) use Concrete Segmental Pavers (CSPs)

(impermeable pavement)

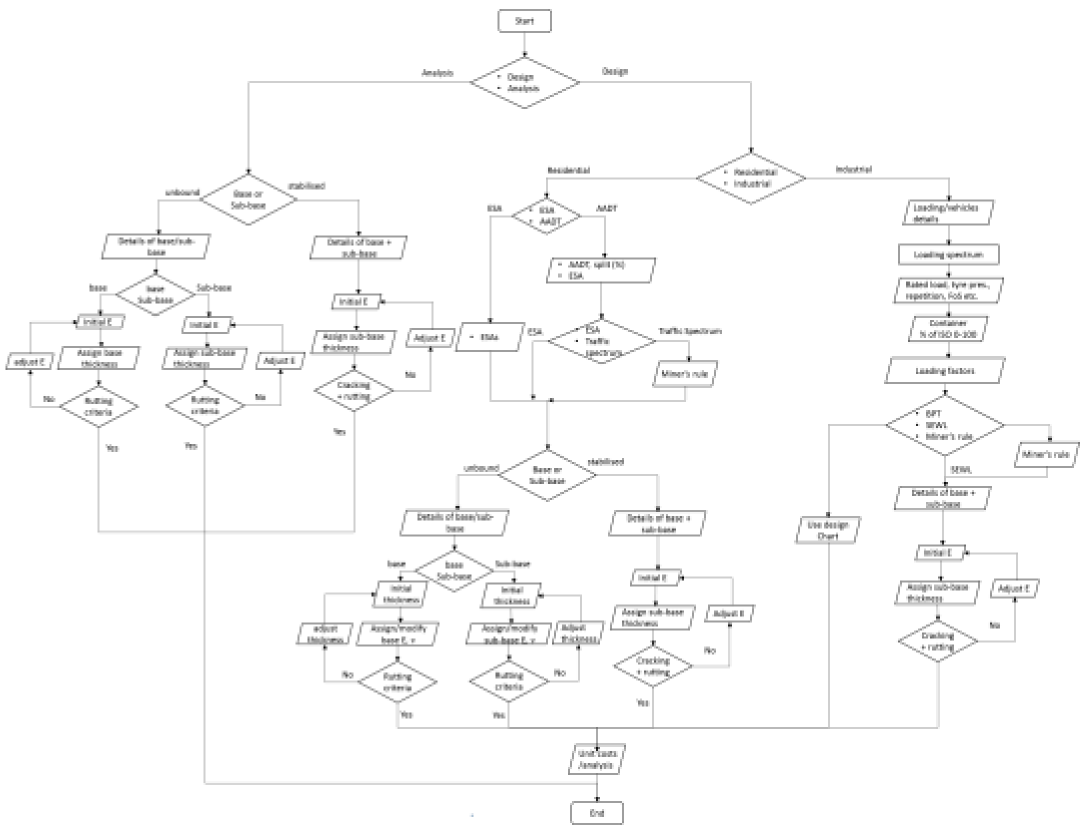
IMEX Terminal, Moorebank, NSW

Permeable Pavements (PPs), also referred to as Permeable Interlocking Concrete Pavements (PICPs)

(permeable pavement, but the pavers are usually not porous)

Laneway, Grange, SA

Design Flowchart



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http://cmaa.com.au/engineering-pavement-software

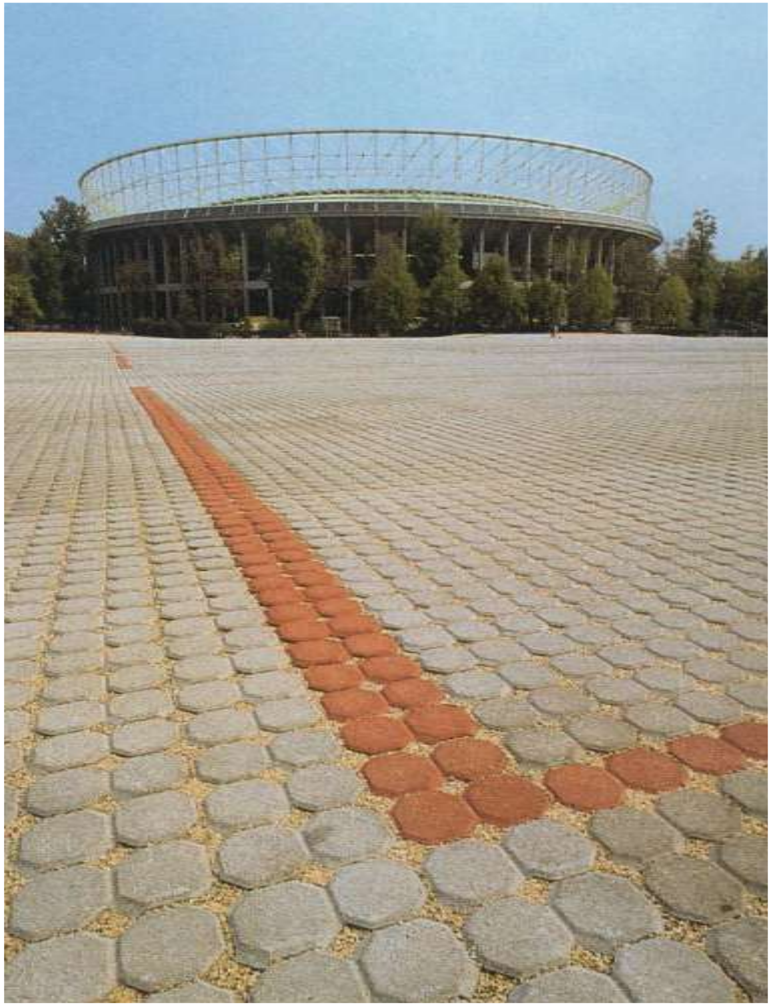
Market Development

- Europe
  - Mid 80s Germany, Austria
  - Mid 90s Belgium, Netherlands etc
  - 2000s UK
    - SUDS – Sustainable Drainage Systems
    - National Government Approach
    - In line with the European Water Framework Directive
  - Top Down – driven by legislation
- USA
  - 1990s: EPA mandated to control stormwater runoff
  - Low Impact Development Centre
  - US Green Building Council
  - Centre for Watershed Protection
  - LEED – Leadership in Energy and Environmental Design to manage runoff
  - EPA established design permits and best management practices – infiltration practices emerged as a major focus

Australian Market

- Bottom up approach – no regulation or national guidance
- Research into PICP began in early 90s
- Routine installation of PICPs introduced in late 90s
  - Market approach project x project basis
  - including prestigious projects such as the Sydney Olympic Precinct – largest landscaping project ever undertaken in Southern hemisphere
    - Only site tested to receive routine maintenance although only a small street sweeper
    - Low infiltration results were due to locations being over buried services

Vienna Football Stadium



- Bus and car park at Prater Stadium, Vienna
- Installed by machine in 1990
- area of 39,000 m^2

Shackel, B., Beecham, S., Pezzaniti, D. and Myers, B. (2008), Design of Permeable Pavements for Australian Conditions, 23rd ARRB Conference, Adelaide, Australia

Chigago White Sox Baseball Stadium Car Park

- EDI designed Lot L at U.S. Cellular Field, home of the Chigago White Sox baseball team
- Converted a 2.43 ha industrial site into a fully permeable parking facility
- At the time of construction (April 2008) it was believed to be the largest permeable paving parking lot in the U.S.
- Permeable system allows for the retention of a 100-year storm event on site, which helps alleviate overloading the existing combined sewer system
- Parking system was constructed at an elevation that allowed an engineered barrier to be placed above the existing Brownfield contaminated site

Chigago White Sox
Baseball Stadium Car Park

- 100-mm-thick L-shaped Eco-Optiloc
- 10mm voids between each stone
- 3.5 cm deep bedding layer of 3 to 6 mm gravel
- 350mm deep basecourse, comprising a mixture of 75mm diameter recycled concrete and 20-25mm limestone gravel
- 527,616 permeable pavers were installed at a rate of 1,900 m^2 a day

www.envdesigni.com/us-cellular-field-lot-l/

Chigago White Sox Baseball Stadium Car Park

- Designed to meet the 2008 City of Chicago Stormwater Management Ordinance
- 2,271 kL of water storage (equivalent to a 100-year ARI rainfall event).
- Equates to a void ratio of e_s = 0.27 (note: graded basecourse)
- Total project cost AUD \$3.8m which was approximately \$432,000 less expensive that a conventional asphalt car park with a pit and pipe drainage system
- Equates to AUD \$155/m^2 total cost

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Morton Arboretum in Lisle, Illinois

- 500 lot car park constructed in 2003 for arboretum that features 4,117 kinds of trees, shrubs and other plants from around the world
- 1.6 ha permeable paving with additional 3,230 m^2 of regular interlocking concrete block pavement
- Initial design and construct cost was AUD $1.05m
- Full life-cycle cost comparison showed that it was less expensive than an equivalent asphalt car park over 25 year lifespan

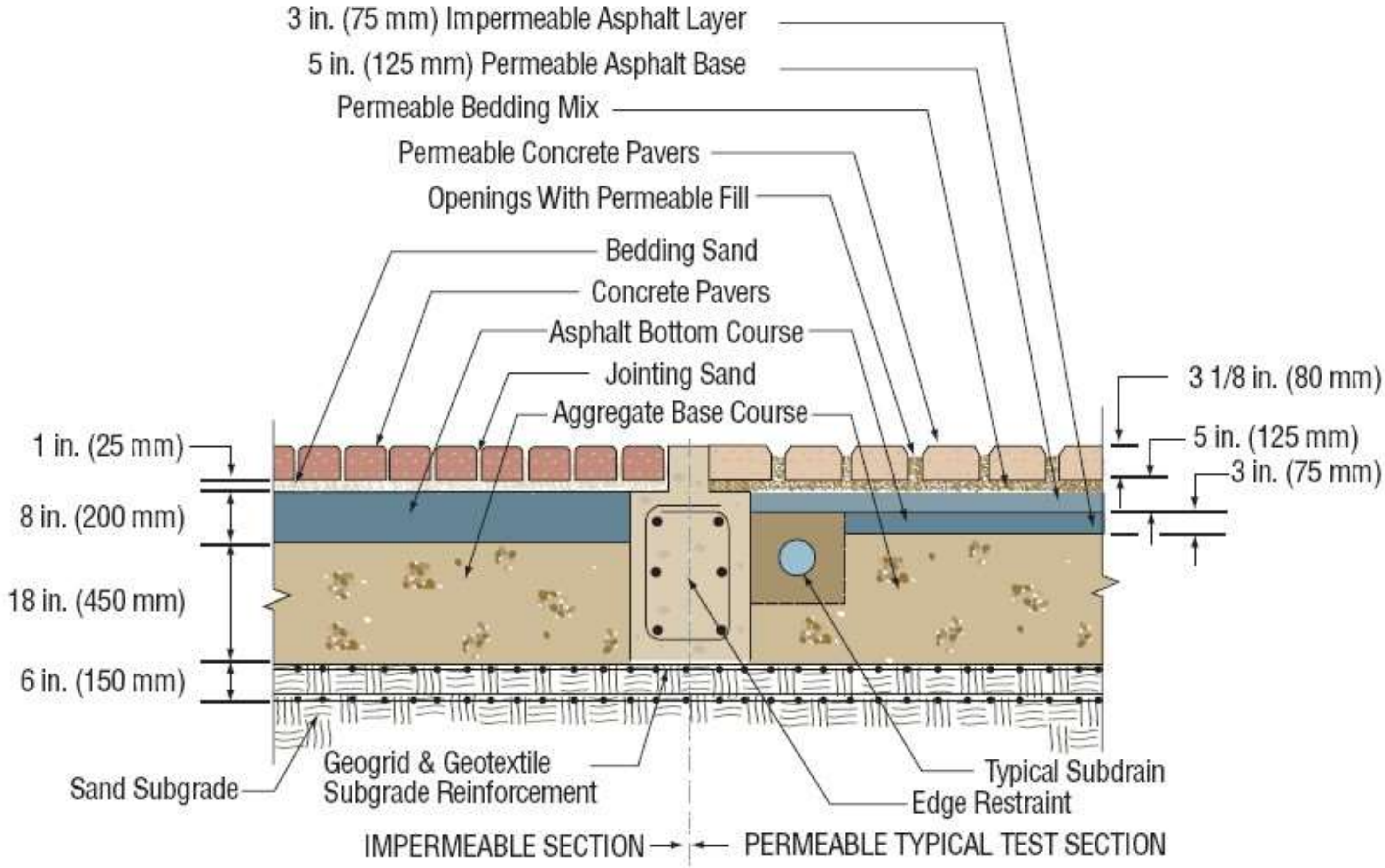
Morton Arboretum in Lisle, Illinois

- 80mm pavers with 3 to 6 mm blue mahogany granite jointing gravel and 40 mm depth of bedding material (Illinois DOT CA-16, 1 to 10 mm crushed stone)
- Basecourse depth of 150 mm of Illinois DOT CA-7 (5 to 25 mm, ASTM No. 57) crushed stone base overlying a further 300 mm of Illinois DOT CA-1 (25 to 63 mm, ASTM No. 57) crushed stone sub-base
- Subgrade was native clay soil
- Biofiltration swale includes native grasses and black-eyed Susans to help filter runoff before it enters Meadow Lake and eventually the DuPage River

Howland Hook Marine Terminal Container Yard, Staten Island, NY, USA

- In both the USA and Brazil permeable paving has been successfully used in container handling areas and ports subject to high wheel loads

Howland Hook Marine Terminal Container Yard, Staten Island, NY, USA



Howland Hook Marine Terminal Container Yard, Staten Island, NY, USA

- Expanded existing container yard by approximately 5 ha with 0.1 ha of permeable interlocking concrete block pavement
- ICBP selected for resistance to container loads, particularly damage at corner castings, and because of the potential subgrade problems (due to presence of gypsum)
- 20-year service life of top picks and lift trucks and 4-high container stacks
- dual wheel axle loads of 97,500 kg excluding dynamic forces
- stacked containers can result in point loads of up to 23,000 kg at each corner casting at the bottom container

The Reeds, Fairlands, Johannesburg

- First system was constructed in 2007 as an affordable housing project
- Some 89,000 square units and 94,000 rectangular units were supplied to cover an area of 4,320m²
- 500mm of top soil was removed and the exposed surface was then covered with an SABS approved BIDIM A5 geotextile
- Rockfill comprising 160mm stone, 500mm deep formed the next layer followed by a second layer of geotextile membrane
- Once compacted, the rockfill was covered with 80mm of coarse washed river sand and this in turn was compacted. To this was added another 20mm of washed river sand for bedding. The same sand was also used for jointing.

www.cma.org.za

Permeable Concrete Block Paving
Witwatersrand University

Two car park areas

13,000m^2

Largest permeable paving project in South Africa

60mm pavers

Durban North Kensington Drive

Durban North Kensington Drive

- Shopping mall
- 480m^2 of paving harvests both roof and pavement runoff
- Includes 500mm concrete detention tank under paving system
- Designed by Arups

Smith Street, Manly

- An Australian retrofit (in 2001) of permeable paving to a residential street originally constructed around 1900
- Ecoloc pavers

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PICP in Kiama, NSW, Australia

- Constructed in 1997

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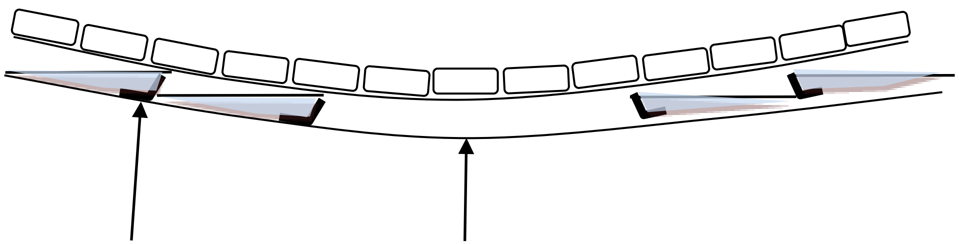
Olympic Park Sydney

- Constructed in 1998
- Installed over dense-graded 20mm granular basecourse (DGB20)

Lane 30 Grange, SA

- Rear access service laneway, constructed in 2010
- 2500m^2 effective contributing area
- Graded permeable basecourse material with a void ratio of 15%

Lane 30 Grange, SA



- Hydraulic conductivity of subgrade = 1.0×10^{-4} m/s (results from falling head test, UniSA report, dated 14 May 2009)
- All storm events for the 5yr ARI shall be managed by the permeable pavement section

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Conclusions

- Permeable pavements can make a significant contribution to sustainability consistent with the concepts of Water Sensitive Urban Design (WSUD)
- Overseas studies show this can be achieved without increase in project costs
- Since the early 1990s, Australian research has embraced measurements of infiltration rates, structural capability, pollution trapping and clogging
- Australian-specific guidelines have been developed for the design of PICPs for managing rainfall runoff, water quality and harvesting and to withstand traffic loads
- PICP can be expected to serve satisfactorily for periods comparable to other forms of pavement (i.e. 25 years)
- Impediments include:
    - Lack of financial and human resources in LGAs to enforce legislation
    - Lack of awareness of environmental benefits and cost savings associated with CSP and PICP
    - Inertia in construction industry and unwillingness to change to new methods

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