Pervious Pavement

An Infiltration BMP – A LID Technique

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Low Impact Development

LID Techniques

LID can be simple and effective. Instead of relying solely on complex and costly collection, conveyance, storage and treatment systems, LID employs a range of economical devices that control runoff at the source.

Representative List

- Bioretention (Rain Gardens, etc.)
- Cisterns/Rain Barrels
- Green Roofs
- Porous Pavements (Permeable Pavements)
- Grass Swales (plus other biofiltration devices)

Source – EPA
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=124

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Porous Pavements

"A porous pavement is one with porosity and permeability high enough to allow water to readily pass and thus significantly influence hydrology, rooting habitat, and other positive environmental effects."

(Per ASTM - formerly known as the American Society for Testing and Materials)

Porous Pavements

Pervious Concrete

Porous Pavements

- A permeable pavement surface
- Replaces Conventional/Traditional Pavement
- Substantial VOIDS in pavement allow stormwater to infiltrate directly into subsoil – usually through a retention layer first
- Underlying stone reservoir (retention layer) immediately beneath the pavement – in most cases (can vary by geography)

Porous Pavements

Basically the same function and uses as conventional pavements

+

ENVIRONMENTALLY RESPONSIBLE pavement designed to allow stormwater drainage to the sub-grade for:

- **Filtration**
- **Groundwater Recharge**
- **Reduction in over-all Runoff**

EPA Phase II Program

US Clean Water Act - NPDES – Natl. Pollutant Discharge Elimination System

- The EPA's Ph II program requires 6 min. control measures:
  - **Education and Outreach**
  - **Public Involvement**
  - **Illicit Discharge Detection & Elimination**
  - **Const. Site Stormwater Runoff Control**
  - **Pollution Prevention for Muny ops.**
  - **Post-Const. Stormwater Mgt. - New Devel. & Re-Development**
    - **1 Acre or more**
    - **ON-SITE STORMWATER TREATMENT BEFORE DISCHARGE FROM SITE**
- EPA offers a list of Best Management Practices (BMPs) to help owners within regulated areas to control runoff. The effective use of **Porous Pavements are an approved BMP** for compliance with Phase II Stormwater regs.

Pervious Concrete
Environmental Benefits

Because water is allowed to percolate into ground, nearby vegetation is watered & reduces irrigation needs, groundwater is recharged & stormwater run-off that remains is improved, yet reduced.

Primary Drivers

Porous Pavements

- Environmental Responsibility
  - Green Building Movement – Market Forces/PR. – May include LEED$_{tm}$, etc.
- Stormwater Regs.
  - US EPA NPDES Phase II, etc.
- Favorable Cost Factors
  - Site Optimization Dynamics

Porous Pavements

PRIMARY TYPES

(most commonly used)

- Pervious Concrete
- Porous Asphalt
- Permeable Pavers

Cost Savings & Improved Site Optimization

Pervious Concrete

Completed – Winter, 2005

- 8 Acre Lot – 12 Acre Site – Westminster, MD
- **$400,000 SAVINGS** – **Underground Drainage *Eliminated*** - original plan
- **1-1/2 Acre Retention Pond *Eliminated*** – original plan & space ***reclaimed*** for facility

Pervious Concrete Pavement

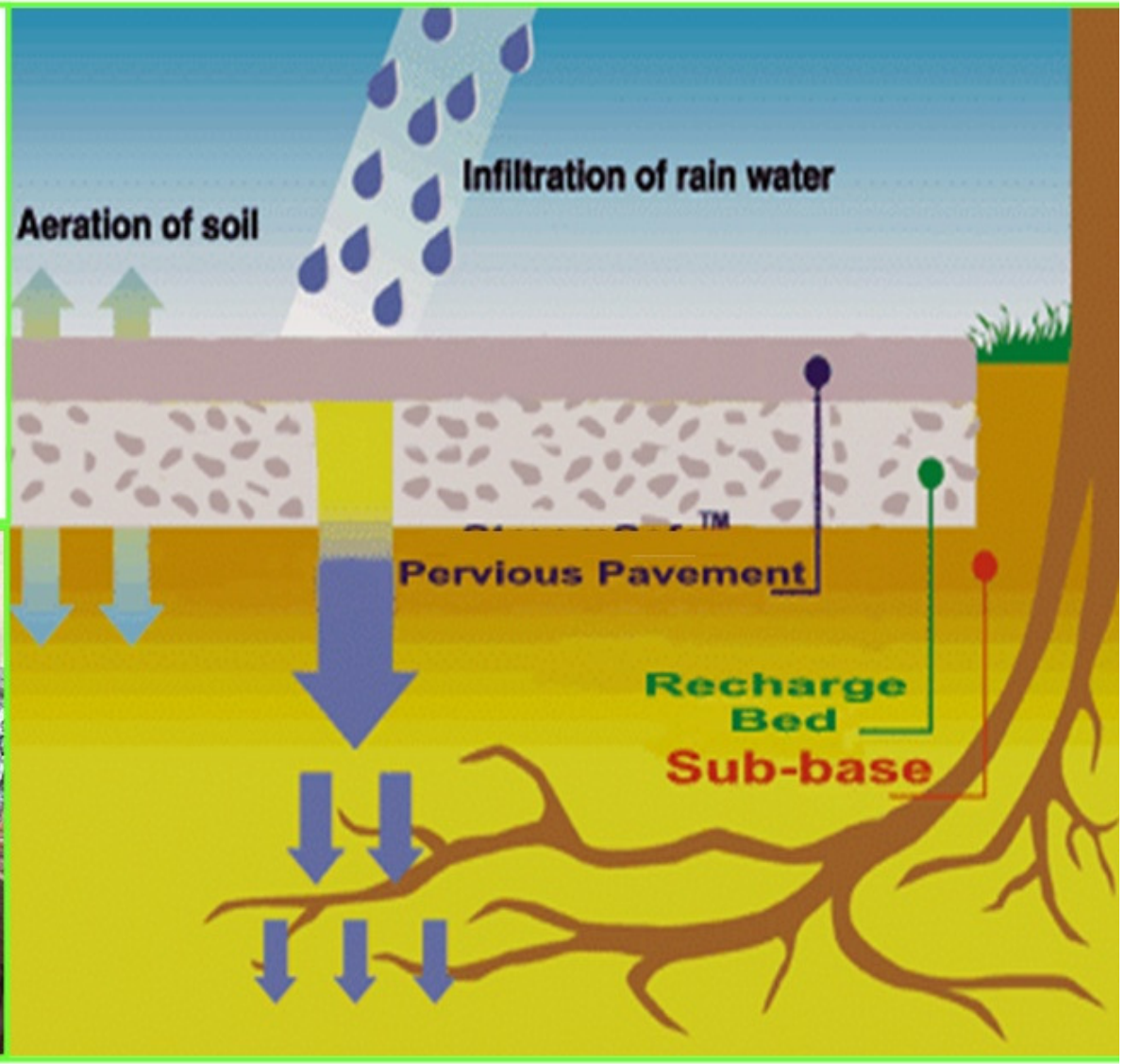
General Description:

- Structural pavement: 500-4000 psi
- Components:
  - Coarse aggregate
  - Portland cement
    - Supplemental mtrls.
      - Fly Ash / Slag
      - Fibers, Integral Color, etc.
  - Water
  - Admixtures
- Void content range of 15-30%
- Designed to allow stormwater drainage to the sub-grade for filtration, ground water recharge & reduction in over-all runoff

Low Impact Development – Pervious Concrete
Directly Infiltrates Water ***Through The Pavement***

The Pervious Concrete "System" is itself a Dry Detention Pond !

Its secondary use is as a pavement



Pervious Concrete

New (?) Approach Being Adopted

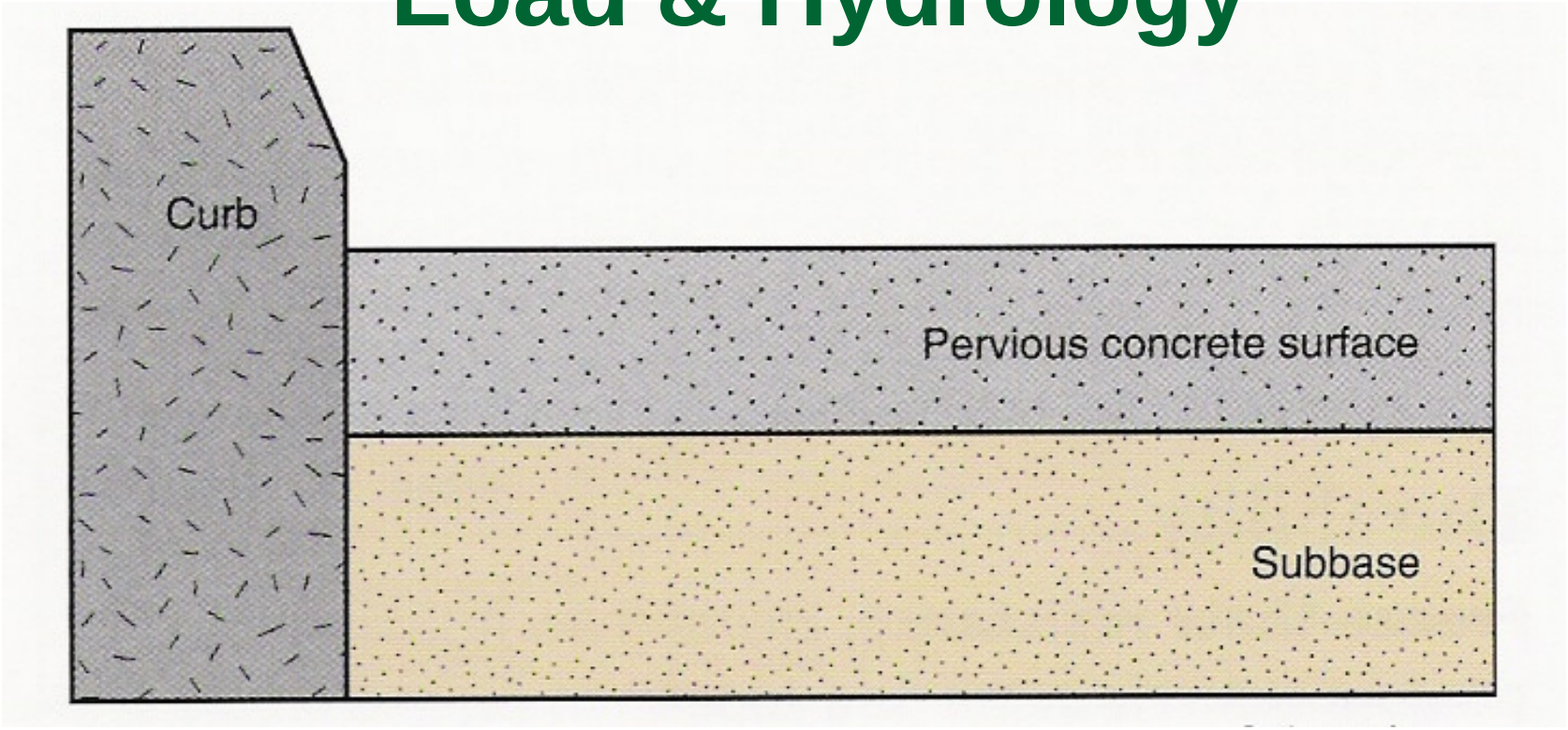
Not so new !

- 1852 – UK housing
- 1923 – Scotland – 50 two-storey houses
- 1930-1942 – 900 homes in Scotland
- After WW2 – Throughout Europe
- 1960's – Eastern Canada
- Worldwide – "no fines" concrete for various specialized purposes
- USA SE – More than 30 yrs.

Pervious Concrete
Most Versatile of Porous Mtrls.

- Parking Areas
- Driveways
- Sidewalks
- Roadways
- Pedestrian Plazas
- Swales & Ditches
- Erosion Control
- Slope Protection
- Load-bearing Walls
- Etc.

Basic Design Considerations
Load & Hydrology



Pervious Concrete

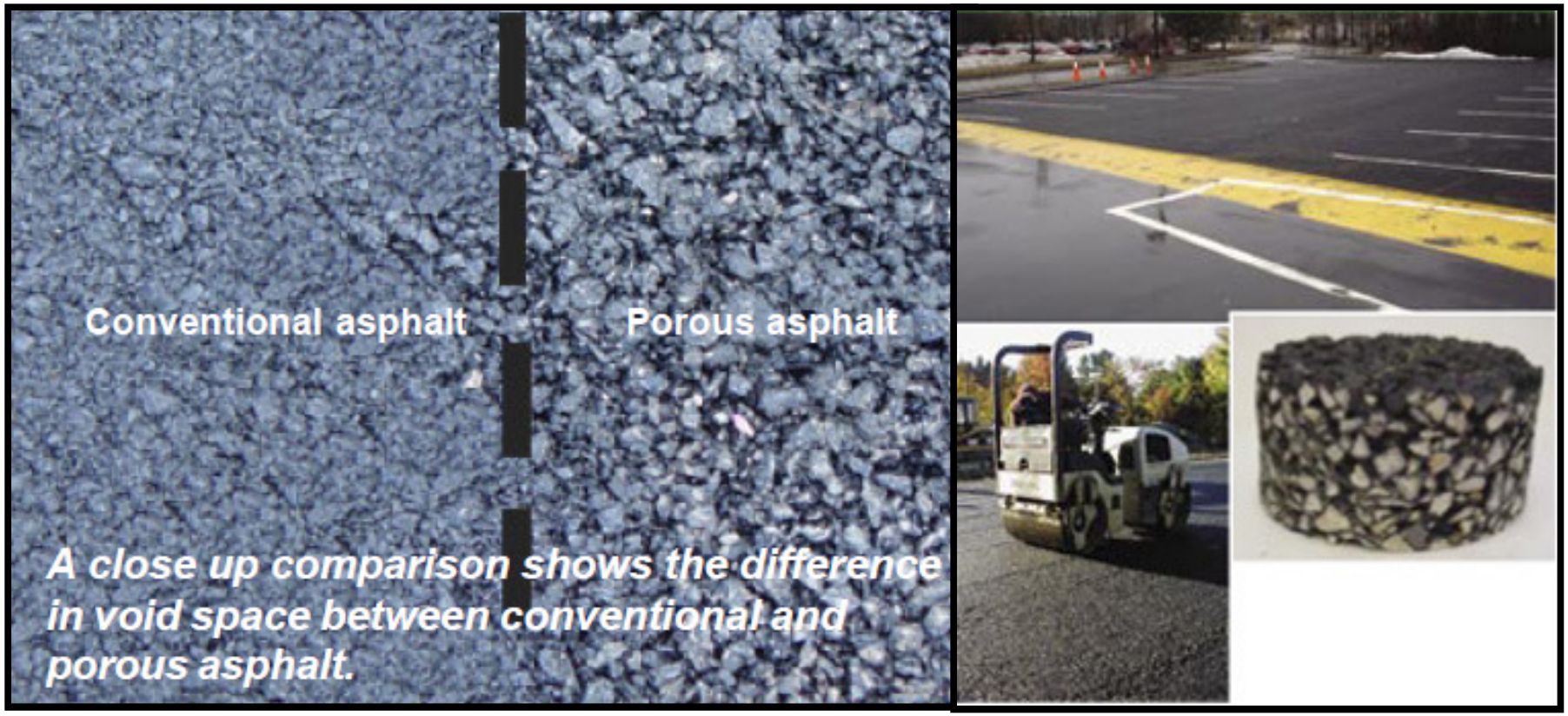
Elimination of Runoff

Passes water at 3-5 gal. per min. per sq. ft.

<u>or</u>

270 – 450 in. per hour !

Porous Asphalt



National Asphalt Pavement Association: www.hotmix.org.

Porous Asphalt

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Porous Asphalt

- 3-1/2” placement compacted to 2-1/2” Thickness (typically)
- 12-36” granular reservoir

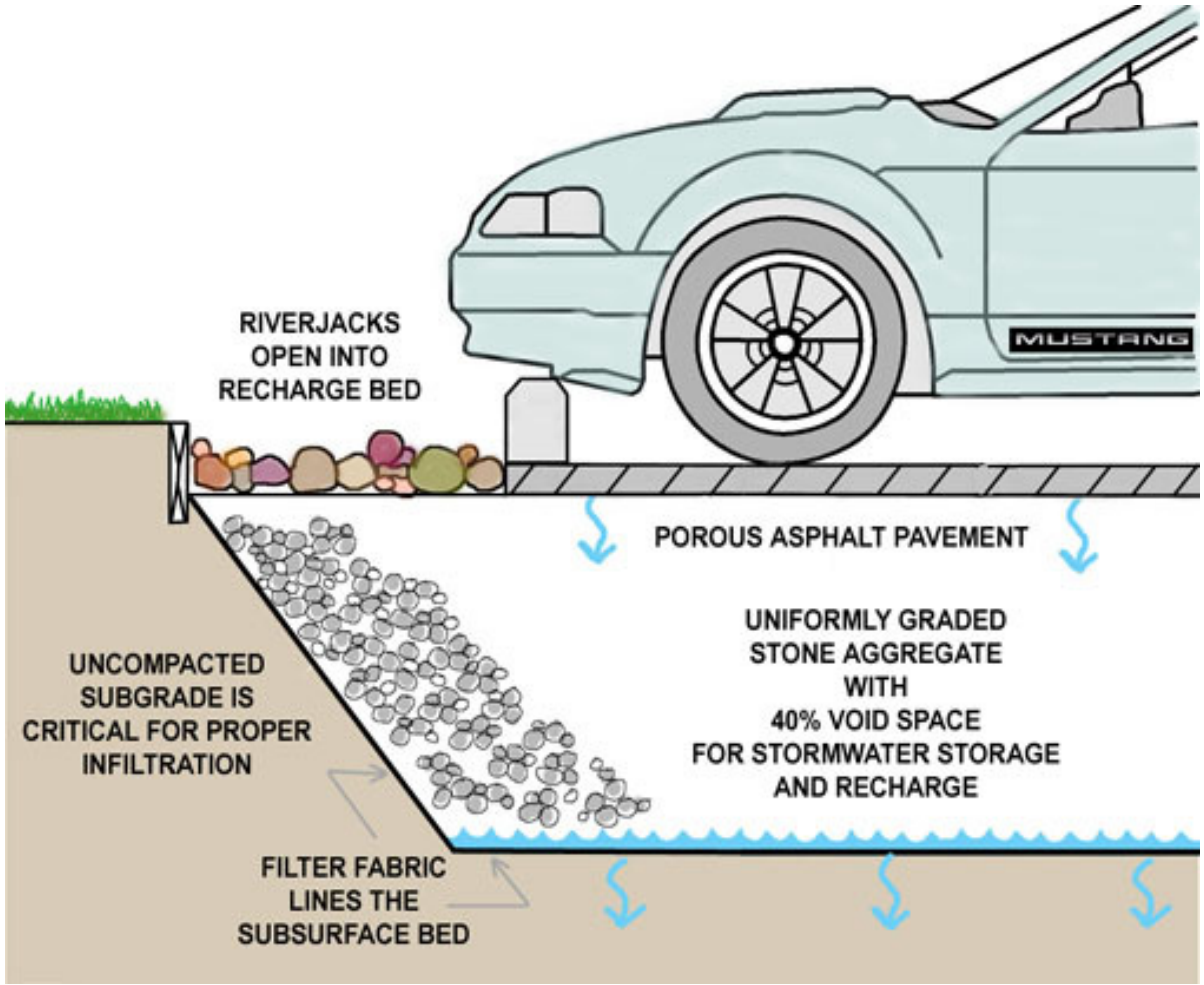
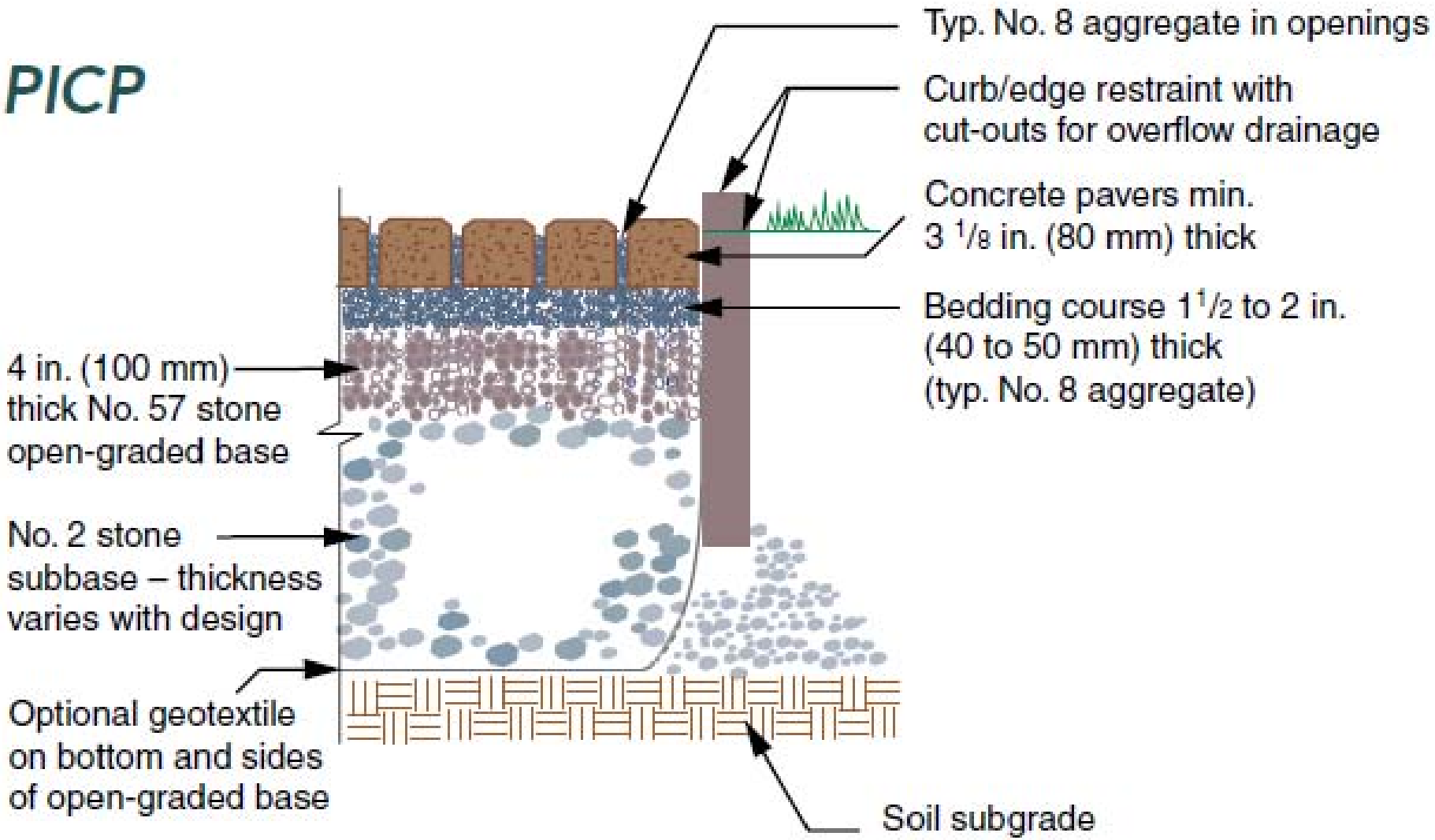


Diagram – Courtesy: Cahill & Assocs.

Permeable Interlocking Concrete Pavers

Source: Interlocking Concrete Pavement Institute – www.icpi.org

Permeable Interlocking Concrete Pavers



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Conventional vs Pervious

Asphalt Pavement **(Left)** (Same Site) Pervious Concrete **(Right)**

Conventional Pavement – Asphalt (Background)

Pervious Concrete (Foreground) - Raining

Pervious Concrete (Foreground) – Heavy Rain

Asphalt vs **Concrete**

ASPHALT (Left)

Coarse Rock

Sand

DARK Color

- Petroleum based binder
- Flexible Pavement
- Lower Light Reflectivity
  - Heat Absorbing - Hotter
  - Night Lighting Increased
- Service Life – Durability **?**
- Environmental Impacts **?**

CONCRETE (Right)

Coarse Rock

Sand

LIGHT Color

- Portland Cement based
- Rigid Pavement
- Higher Light Reflectivity
  - Heat Deflecting - Cooler
  - Night Lighting Decreased
- Service Life – Durability **?**
- Environmental Impacts **?**

Comparative Porous Pavements

Most Distinctive Positive Attributes

(Representative List)

- **Pervious Concrete** – Long-term durability, light reflectivity, many certified installers, ability to bear loads, maintains its porosity, versatility of applications
- **Permeable Pavers** – Great for smaller applications, many different patterns, much of product is pre-manufactured off-site, load bearing
- **Porous Asphalt** – Installer availability, consistent color (always black), speed of construction, similar appearance to conventional asphalt pavement

Freeze-Thaw Durability

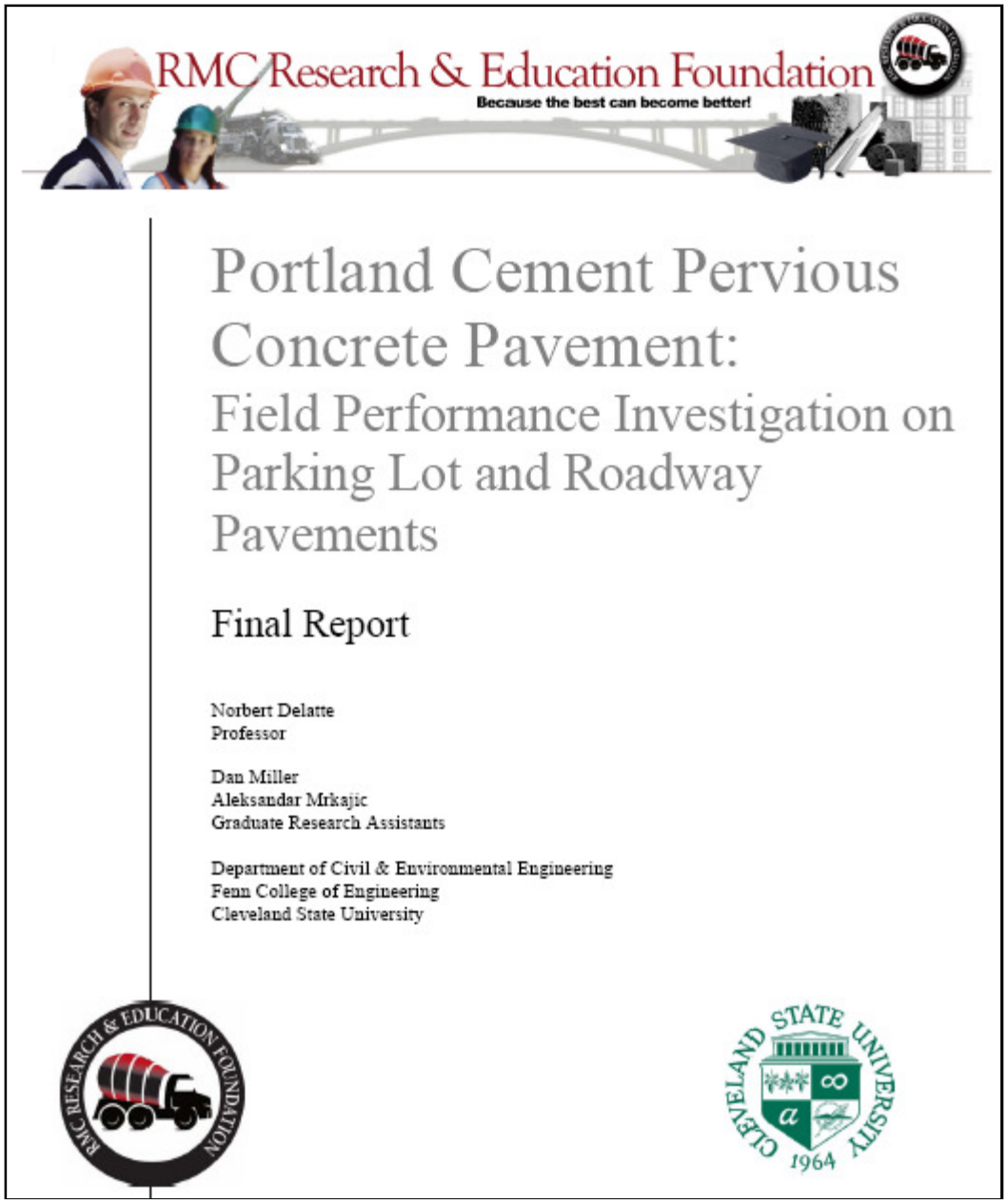
www.rmc-foundation.org

Extensive national survey of past projects by experts concludes: **“The installations have not shown any signs of freeze-thaw damage.”**


NRMCA • 900 Spring Street, Silver Spring, MD 20910 • www.nrmca.org • (888) 84NRMCA

May 2004

Freeze-Thaw Resistance of Pervious Concrete


RMC Research & Education Foundation

Because the best can become better!

Portland Cement Pervious Concrete Pavement:

Field Performance Investigation on Parking Lot and Roadway Pavements

Final Report

Norbert Delatte
Professor

Dan Miller
Aleksandar Mrkajic
Graduate Research Assistants

Department of Civil & Environmental Engineering
Fenn College of Engineering
Cleveland State University

RMC RESEARCH & EDUCATION FOUNDATION

CLEVELAND STATE UNIVERSITY 1964

Porous Pavements

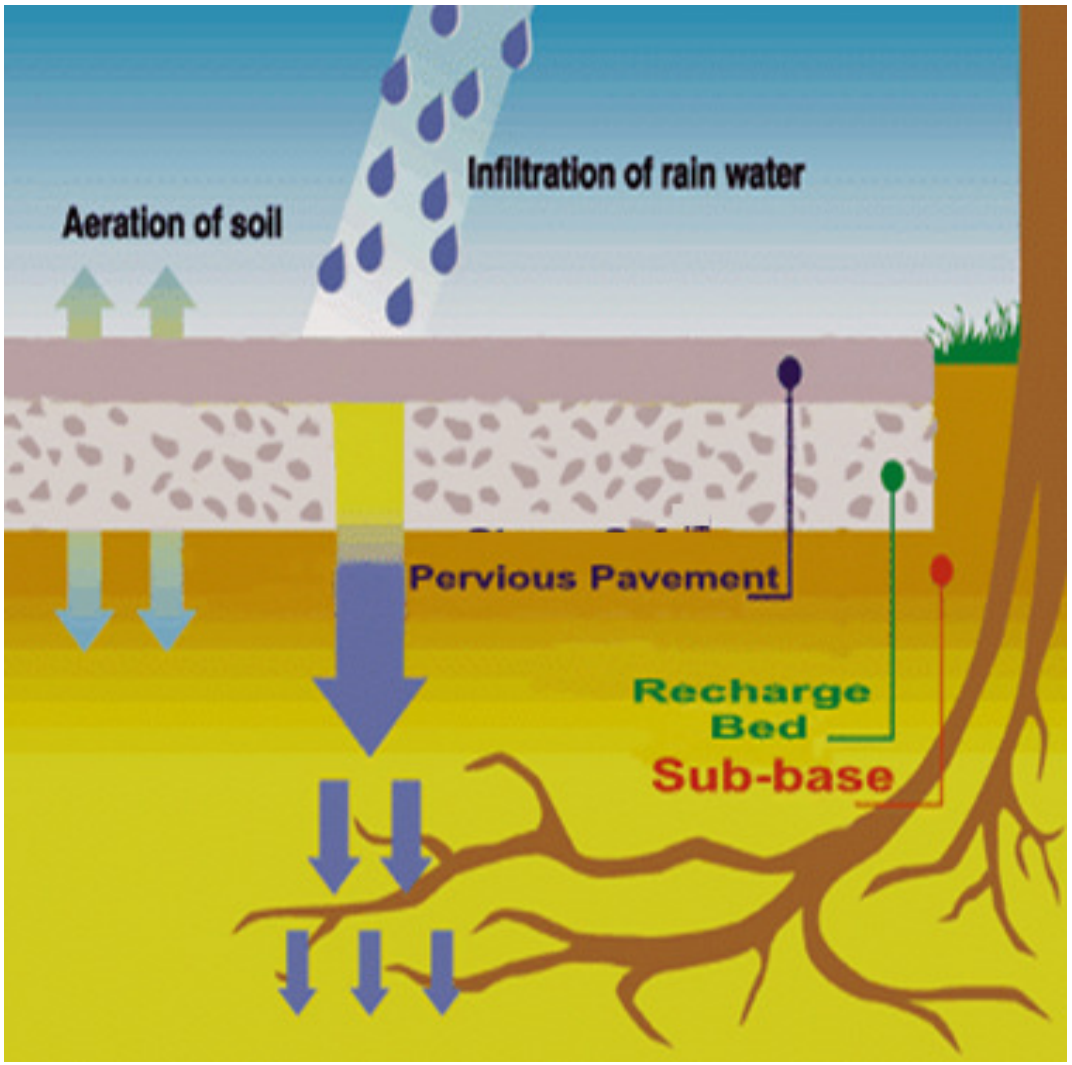
Siting & Design Considerations

- **Siting**
  - Soil Percolation Rate – ½” per hr. min. (Soils Reports!)
    - Supplemental Drainage MAY overcome
  - Relative Flatness of Stone Reservoir
  - 100 ft. from water wells intended for drinking water & 2-5 ft. above seasonal high water table if near very high contaminate sources (i.e. industrial sites)
  - Low-Medium traffic areas – Parking Lots, Residential Rds., Pedestrian Areas, etc.

(Source: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=71)

Porous Pavements

Siting & Design Considerations



Porous Pavements - Many kinds of uses!


Cost Savings / Site Optimization

Pervious Concrete

Park & Ride Parking Lot (4 acres)

Serving Site of 2008 Super Bowl – Glendale, Ariz.

Pervious Concrete Parking Lot - 2 ½ Acres

K-8 School – Meridian (Boise), Idaho

Frequent Commercial Apps.

Branch Bank - Bank of America


WAL★MART
SUPERCENTER
FOOD CENTER
Open 24 Hours

Pervious Concrete Shopping Center Entrance/Service Road

“Canyon Crossing” – Puyallup (Seattle), WA


ECKERD
PHARMACY
ECKERD
ECKERD

Prime Outlets – Williamsburg, VA

- 7.6 acres Pervious Concrete
- 3.5 acres Conventional Concrete


20 year old retention pond behind the mall

Pervious Concrete Over Former Detention Pond

Prime Outlets – Williamsburg, VA

- Infiltration system design includes water harvesting
  - utilizing underground stormwater chambers

Pervious Concrete Parking Stalls
Conventional Concrete Drive Lanes

Residential City Streets

Composite Design – Portland, Oregon


Pervious Concrete – Portland, Oregon

Architectural Pervious Concrete

Univ. of Calif. - Berkeley


JAN 28 2003

Along Mississippi River – Minneapolis Metro


Stamped Pervious Concrete – Fresno, Calif.

Architectural Pervious Concrete

Progressive Concrete Works - Phoenix

China – S. of Shanghai (3 mil.+ sq. ft.)

Quil Ceda Creek Casino
Tulalip Tribe

- Marysville, WA (N. of metro. Seattle)
- Parking Lot Expansion – 200,000 sq ft (4.6 acres)
- Tulalip's heritage deeply rooted in fishing
  - Good stewards of Land and Water
  - Concerned about potential impacts of pollutants and water temp. increase on fish and habitat
  - Concerned about petroleum based pavement materials – (the most commonly used conventional product)
  - Needed to expand their existing parking lot

Stormwater

Environmental Perspective

Conventional Stormwater Mgt.

Impervious parking lots (conventional pavements), roads, and roof tops cause more stormwater runoff & **thermal pollution** greatly affecting fish and aquatics habitat plus vegetation – ALL bodies of water

Quil Ceda Creek Casino

Tulalip Tribe

Quil Ceda Creek Casino

Tulalip Tribe

Pervious Concrete

Filters Water in Excess of 270 Inches of Rain Per Hr.

Quil Ceda Creek Casino – Marysville, WA

Porous Pavements

Online Resources

- www.epa.gov
- www.perviouspavement.org
- www.icpi.org
- www.hotmix.org
- www.concretethinker.com
- www.usgbc.org

Porous Pavements

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