Concrete Solutions to Storm Water Runoff

Presented By: Jonathan Kuell, Executive Director:

NORTHERN NEW ENGLAND CONCRETE PROMOTION ASSOCIATION
Topics of Discussion

- Properties of Pervious Concrete
- Applications
- Benefits
- Design Considerations
- Placement Guidelines
- Freeze-Thaw Durability
- Project Review
What is Pervious Concrete?

- A No-Fines Concrete Mix
  - Coarse Aggregate
  - Portland Cement
  - Water
- Intended for use as an open-graded drainage material
Typical Pervious Concrete Mix Design

- 550 – 650 lbs. Portland Cement
  - Fly Ash / Slag Cement substitute acceptable at standard rates
- 27 ft$^3$ Coarse Aggregate
  - Aggregate size will affect drainage rate
- 0.25 – 0.35 W/C Ratio
  - Sufficient water to display a wet, metallic sheen on the aggregate
Pervious Concrete Properties

• 15% to 35% air void content
• 100 to 120 lbs/ft³ unit weight
• 500 to 3000 psi strength*
  • Introduction of small amount of fine aggregate can increase strength to 4000 psi (+/-)
  • compressive strength typically not used as acceptance criteria. Air void structure and unit weight are used instead.
Pervious Concrete Properties

- Drainage rate = 3-5 gal/sec/ft$^2$
- Equivalent of 275” to 450” of rain per hour!
  - More than half of all rainfall is provided in rain events that total one-half inch or less.
- 6” section with 20% voids holds 1 – 1 ¼” of rain water
## Standard C-Factors

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>Coefficient of Runoff</th>
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<tbody>
<tr>
<td><strong>Concrete or Asphalt</strong></td>
<td><strong>1.00</strong></td>
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<td>Gravel - Compact</td>
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<tr>
<td>Clay - Bare</td>
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Pervious Concrete should fall between these factors.
Typical Applications for Pervious Concrete

- Light Duty Parking Areas
- Nature Trails / Park Pathways
- Greenhouses / Nurseries
- Erosion Control
- Environmentally Sensitive Developments
Parking Lots & Pavements: Environmental Disasters

- Almost Total Runoff
- Public Water Needed for Vegetation
- Valuable Water Resources are Wasted
- Runoff Has Chemical Pollutants, Requiring Treatment
- Runoff is Hotter, Damaging Ecosystems
- Rapid, High Volume Runoff Requires Larger Public Drainage Facilities
- Hot Parking Lots Add to Urban Heat Island Effects
First Flush

- Pervious concrete pavement reduces runoff
  - Cleaner first flush
  - Captured by void structure
  - Minimization of PAH
- Soil chemistry and biology will naturally treat water
  - Oil drips and other automotive pollutants are “attacked” by naturally occurring soil microbes
An EPA BMP

• For stormwater pollution prevention

• Lower heat island effect

• Pervious concrete is eligible for LEED credit points for the USGBC Green Building Rating System.
Cost Advantages

• Savings to Municipalities
  • Reduces stormwater utility fees
  • Minimize upgrade of existing systems to keep up with development
    • Cerritos, CA
    • 90,000 ft² Pervious Concrete Parking Lot
    • City saved between $250K and $500K

• Savings to Owners/Developers
  • Eliminates need for retention ponds & other costly stormwater management practices
  • Provides for more efficient use of land development
Shelter Systems Ltd.
Westminster, MD

• Approximately 8 acres of pavement
• Saved $400,000 in underground drainage construction costs
• Eliminated 1 ½ acre retention pond
Pavement Design Thickness

- Hydrological Design Considerations of pavement & related base materials (stormwater storage capacity)
- Mechanical Properties (load carrying capacity)
- Choose greater thickness of these needs
- Base design important to storage as well
- Hydrological Design software is now available
Infiltration Systems

• Developed in 1970’s
  • Franklin Institute, Philadelphia, PA
  • Have been used for over 20 years
• Pervious concrete: 4-6 inches typical
• Open-graded stone subbase: determined by local hydrologic conditions
• Geotex prevents movement of fines into stone bed
• Perforated pipe to capture water & let it drain (optional)
• Water drains through pavement into stone bed and infiltrates slowly into underlying soil mantle
  • 0.1 – 0.5 in/hr acceptable
  • Total drawdown time should not exceed 5 days
Pervious Concrete Placement

Many ways to place pervious, including:

• Roller Screed
• Asphalt Paver
• Laser Screed
• Vibratory Truss Screed
Finishing: The Typical Process

- Spreading
- Strike-off
- Compacting
- Jointing/Edging
- Curing
Hydraulic Roller
Surface Texture

• Important to keep the voids open
• Do NOT use trowels
• Do NOT seal the surface
• No roller marks
Pervious Concrete Placement

• Can also use paving equipment
  • May still require side forms
    • Material usually not stiff enough for edges to hold under pressure of compaction
  • Conventional asphalt paver provides 90% (+/-) compaction
• For denser surface, follow behind with plate tamp or small roller
Durability of Pervious Concrete

- Directly related to proper placement
  - Maintain W/C ratio
  - Proper compaction of pervious surface
  - Proper curing is a must!
  - Specify an NRMCA Certified Pervious Concrete Contractor!
Can Pervious Concrete Withstand Freeze-Thaw?

• Proper mix design
• Proper placement
• Proper maintenance
Consider Conventional Concrete

- A/E required to relieve pressures in conventional concrete mix
  - Tight matrix holds moisture
  - Critically saturated > 91%
- A/E provides void structure for expansion of moisture during freeze
  - 4% to 8% air entrainment
  - 0.01 inch spacing factor
Pervious Concrete

- 15-35% void structure means little moisture trapped in matrix
  - Less likely to be saturated
- Expansion of moisture due to freezing does not exert undue pressures on matrix
- 0.25-0.35 W/C equals high quality paste
- Air entraining admixture protects the coating paste
Freeze-Thaw Resistance

- Depends on saturation level
- Avoid critical saturation
  - Maintenance
    - Annual cleaning in severe climates
  - Design
    - Infiltration System
    - Secret of success is to provide the water a place to go
Snow Packing

- Anecdotal evidence suggests snow-covered pervious clears quicker than impervious surfaces
  - Less need for snowplowing
- Water drains through pavement into stone bed
  - Water does not pond & re-freeze
  - Formation of “black ice” is rare
- Open-grade beds act as insulation
Grocery Store
Denver Colorado
Grocery Store
Denver Colorado
Grocery Store
Denver Colorado
Denver, CO

Pervious Concrete     Conventional Asphalt

Sites directly across street
Photos: 5 min. differential max
Denver, CO

Pervious Concrete  Conventional Asphalt

Sites directly across street
Photos: 5 min. differential max
Study conducted by NRMCA
Results available at www.nrmca.org
What About Clogging?

• Even if 100% clogged with dirt, pervious concrete will still be permeable
• For maintenance, clean pervious pavement with power scrubber
• And/or power wash
• Conventional pavement sweeper/vacuum equipment can also be used
Cleaning can restore 90+% of original permeability.
Let’s Look at Some Recent Projects
• Shelter Systems, Ltd.
  • Westminster, MD
• Placed 2004
• Wet Freeze
  • 90 cycles/yr
Meeting the Customer’s Needs

- Required heavy duty pavement
  - 30 to 40 trucks per day
- R/M adjusted mix
  - Added 500 lbs. fine agg. per CY
  - Flexural strength = 650 psi (7 days)
  - Placed with ABG dual-compaction paver
  - Rolled with small static roller
• Approximately 8 acres of pavement
• Mix design can accommodate 80” of rain per hour
• 10 times intensity of 100 year rainfall event!
• Saved $400,000 in underground drainage construction cost
• Allowed owner to close 1 ½ acre retention pond
- SR 23
- Sussex, NJ
- July, 1999
- Slope Erosion
“Yeah, but,,,“

“That will never work around here”
May, 2004 Placement
Williston, VT
May, 2004 Placement
Williston, VT
UNH Cold Climates Study
White Park – Concord, NH
Park and Ride – Randolph, VT
Downtown St. Albans, VT
• Over 1.2 MILLION YARDS of pervious concrete was placed in preparation for the 2008 Summer Games in China
For further information . . .

• Available from NNECPA
For further information . . .

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www.perviouspavement.org
Questions?
Thank You!

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www.concreteparking.org