

Concrete Solutions to Storm Water Runoff



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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





The image shows the front of a box of Kellogg's Rice Krispies Treats. The background is a vibrant blue with a subtle pattern of white stars. In the top left corner, the Kellogg's logo is displayed in red, with the names of the three cereal mascots—Karl the Great, Trixie, and Pal—shown in a circular frame below it. The product name "RICE KRISPIES TREATS" is written in large, bold, white letters with a thick blue outline, slanted upwards. To the right of the title, the text "crispy marshmallow squares" is written in a smaller, white, sans-serif font. The central focus is three golden-brown, square-shaped treats. One treat in the foreground is broken in half, revealing the internal structure of rice cereal grains bound together by a sticky, golden marshmallow coating. Below the broken treat are three individual white marshmallows. In the bottom left corner, the words "THE Original" are written in a white, stylized font. In the bottom right corner, the number "16" is enclosed in a white circle, followed by the words "Original Size BARS" in a white, bold font. Below this, the net weight "NET WT. 12.4 OZ. (352g)" is printed in a smaller white font.

Kellogg's[®]

TM TM TM

RICE KRISPIES TREATS[®]

crispy marshmallow squares

THE Original

16 Original Size BARS

NET WT. 12.4 OZ. (352g)

Typical Pervious Concrete Mix Design

- 550 – 650 lbs. Portland Cement
 - Fly Ash / Slag Cement substitute acceptable at standard rates
- 27 ft³ 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/ft²
- 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

Soil Texture	Coefficient of Runoff
Concrete or Asphalt	1.00
Gravel - Compact	0.70
Clay - Bare	0.75
Clay - Light Vegetation	0.60
Clay - Dense Vegetation	0.50
Gravel - Bare	0.65
Gravel - Light Vegetation	0.50
Gravel - Dense Vegetation	0.40
Loam - Bare	0.60
Loam - Light Vegetation	0.45
Loam - Dense Vegetation	0.35
Sand - Bare	0.50
Sand - Light Vegetation	0.40
Sand - Dense Vegetation	0.30
Grass Areas	0.35

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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

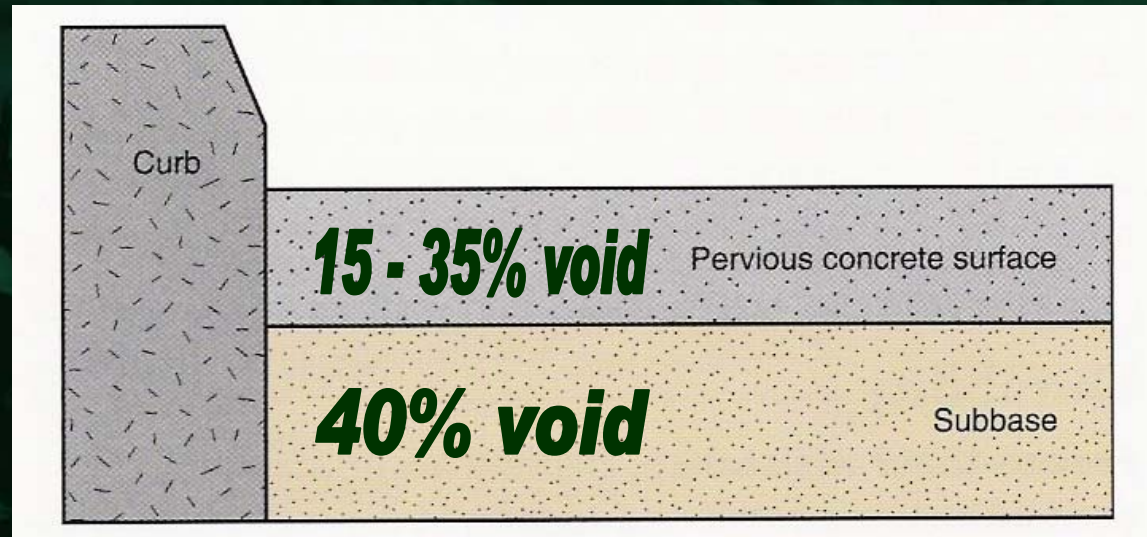


Pavement Design Thickness

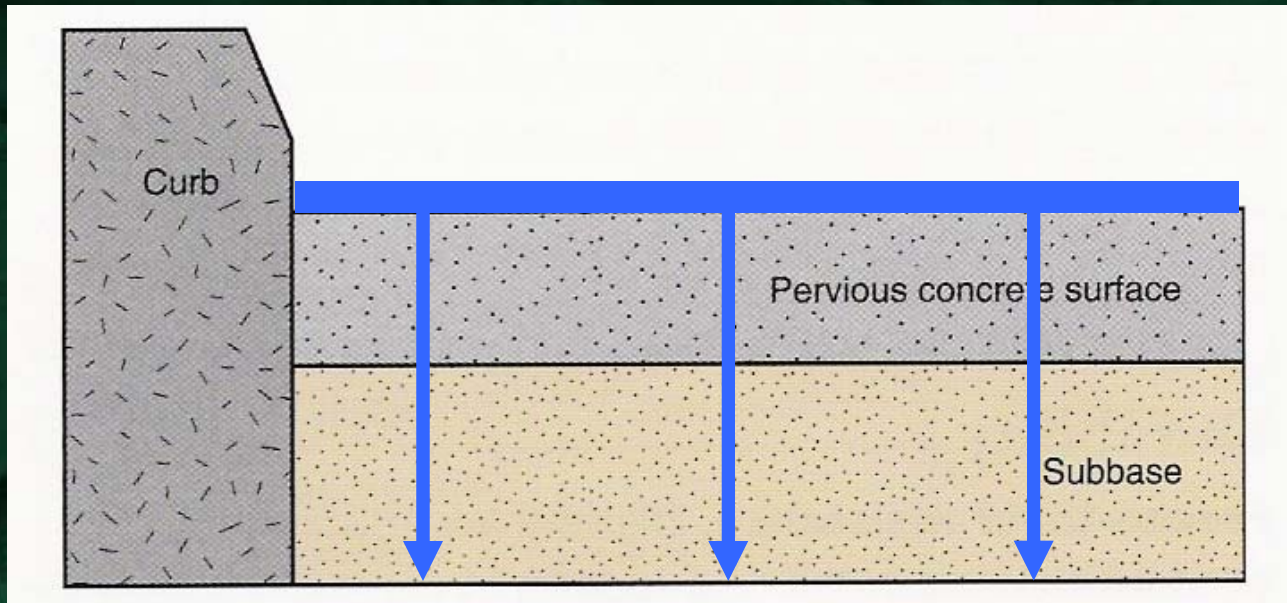
- Hydrological Design Considerations of pavement & related base materials (stormwater storage capacity)
- Mechanical Properties (load carrying capacity)
- Choose greater thickness of these needs
- Base design important to storage as well
- Hydrological Design software is now available

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

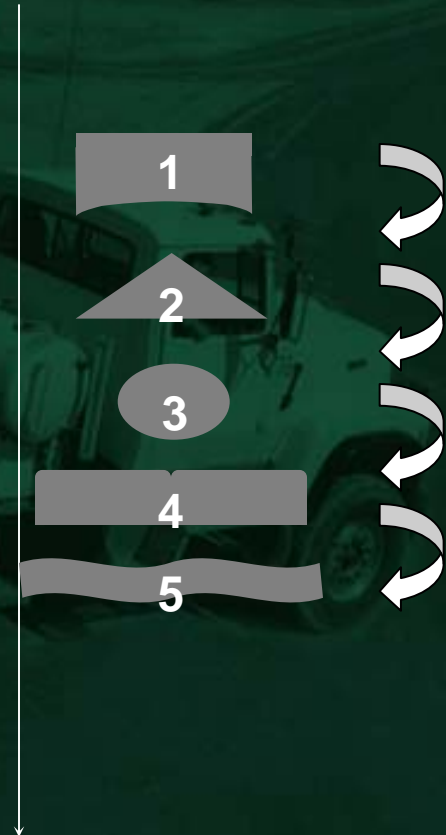
Pervious Concrete Placement

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



Freeze-Thaw Resistance of Pervious Concrete



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

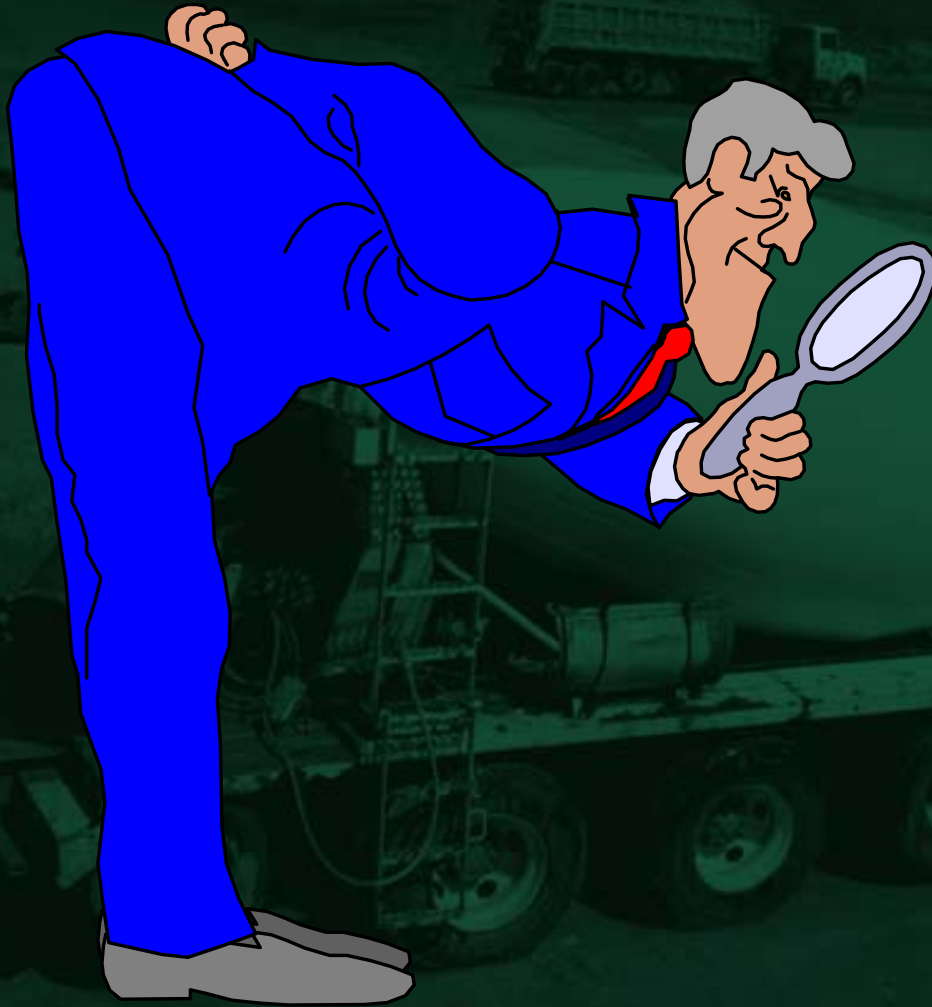


- Conventional pavement sweeper/vacuum equipment can also be used





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!

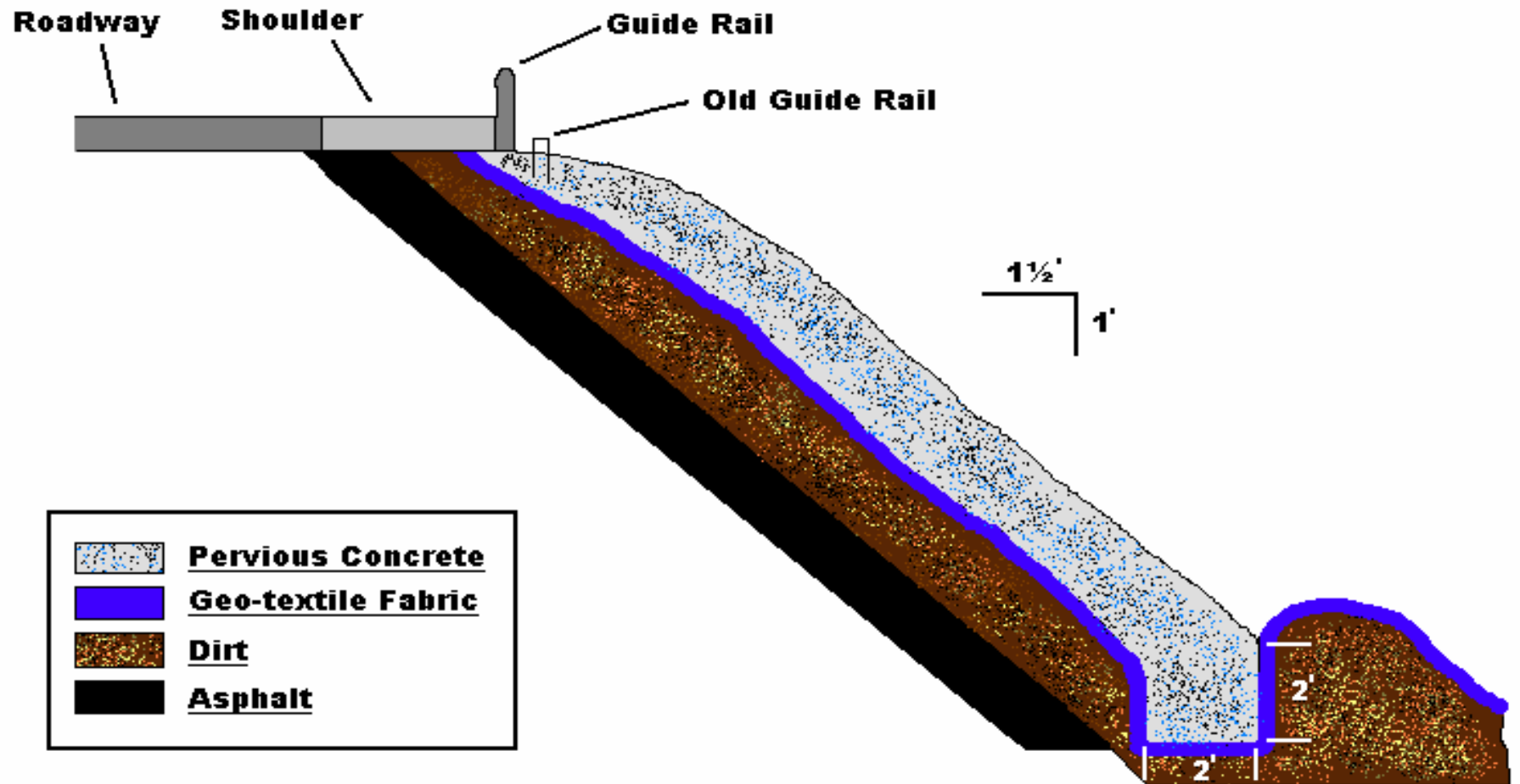


- Saved \$400,000 in underground drainage construction cost
- Allowed owner to close 1 ½ acre retention pond



- 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



May, 2004 Placement Williston, VT





UNH Cold Climates Study



UNH Cold Climates Study



KINGDOM HALL
of
Jehovah's Witnesses





White Park – Concord, NH





Park and Ride – Randolph, VT







Downtown St. Albans, VT









St. Albans

ST. ALBANS CITY

Eaton's FINE JEWELRY

the dressing room

SWEATERS

Needleman's

- 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



Pervious

Concrete

Pavements

Paul D. Tennis

Michael L. Leming

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For further
information . . .

- Available from
NNECPA



For further information . . .



www.perviouspavement.org



Questions?

NORTHERN NEW ENGLAND
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ASSOCIATION



Thank You!

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