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NATIONAL READY MIXED CONCRETE ASSOCIATION

Pervious Concrete Pavements Industry Focus

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NRMCA

Announcement

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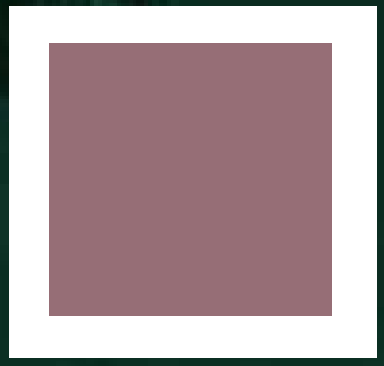
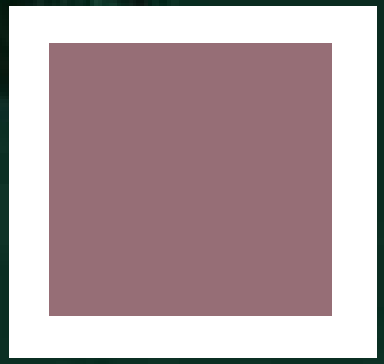


Announcement

- Qualifies for
  - 1 AIA/CES Learning Unit
  - 1 Professional Development Hour (PDH)
  - 0.1 Continuing Education credit




Link to Video

Topics of Discussion

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

Typical Applications for Pervious Concrete

Parking Areas

Nature Trails / Park Pathways

Greenhouses / Nurseries

Erosion Control

Environmentally Sensitive Developments

Reduced Runoff

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.....keeping our little friend Wally healthy!!

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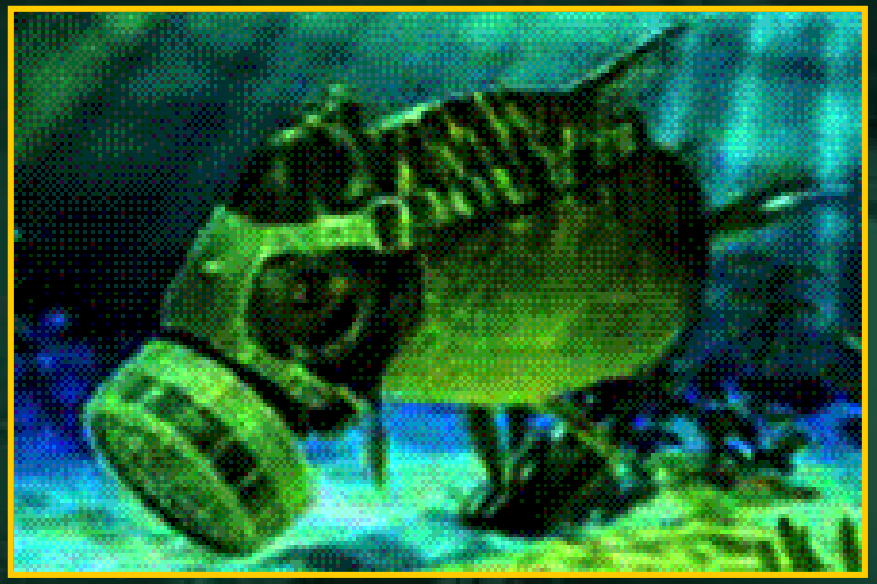

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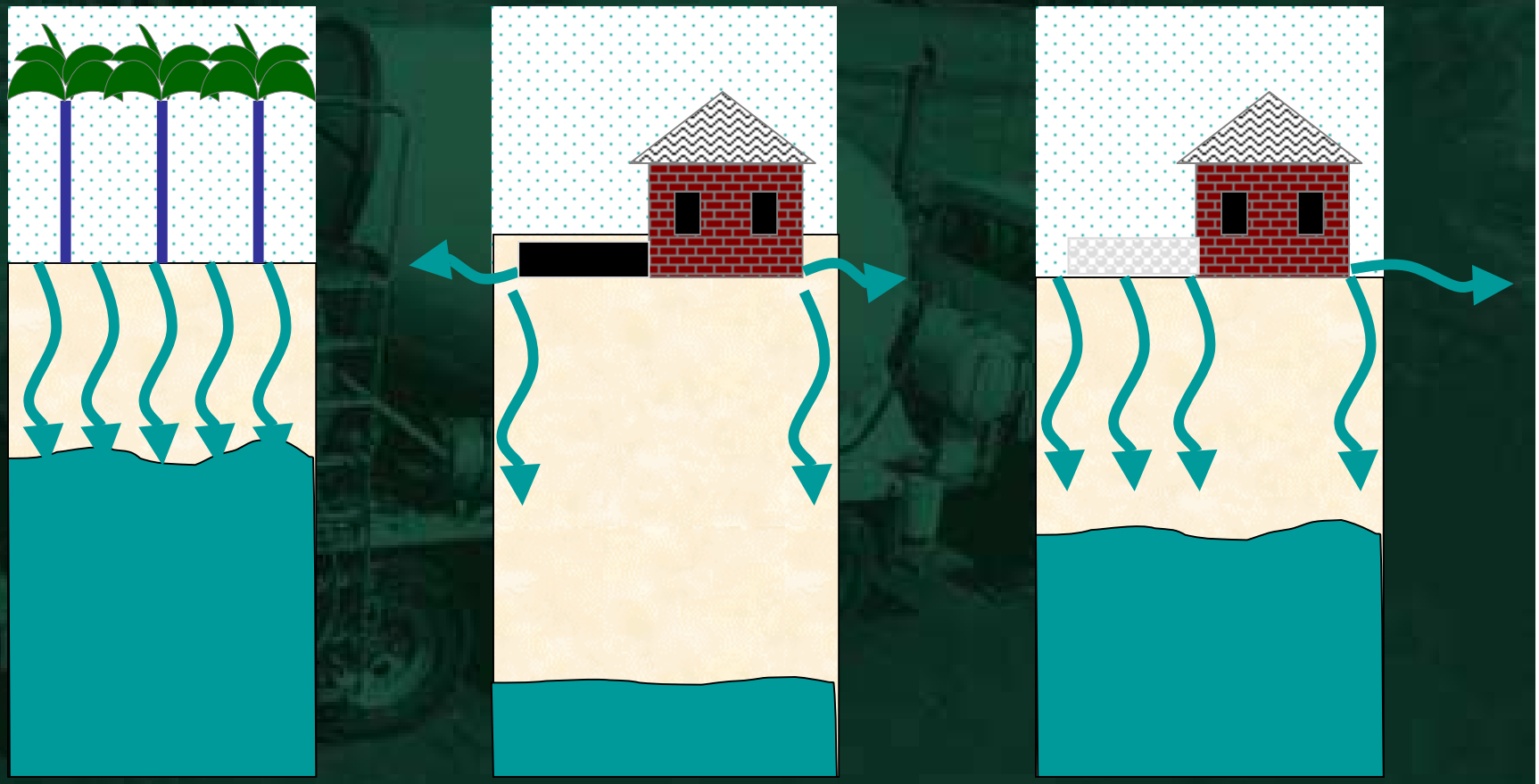
Your Drinking Water



Pre-Development

Post-Development

Low-Impact Dev.

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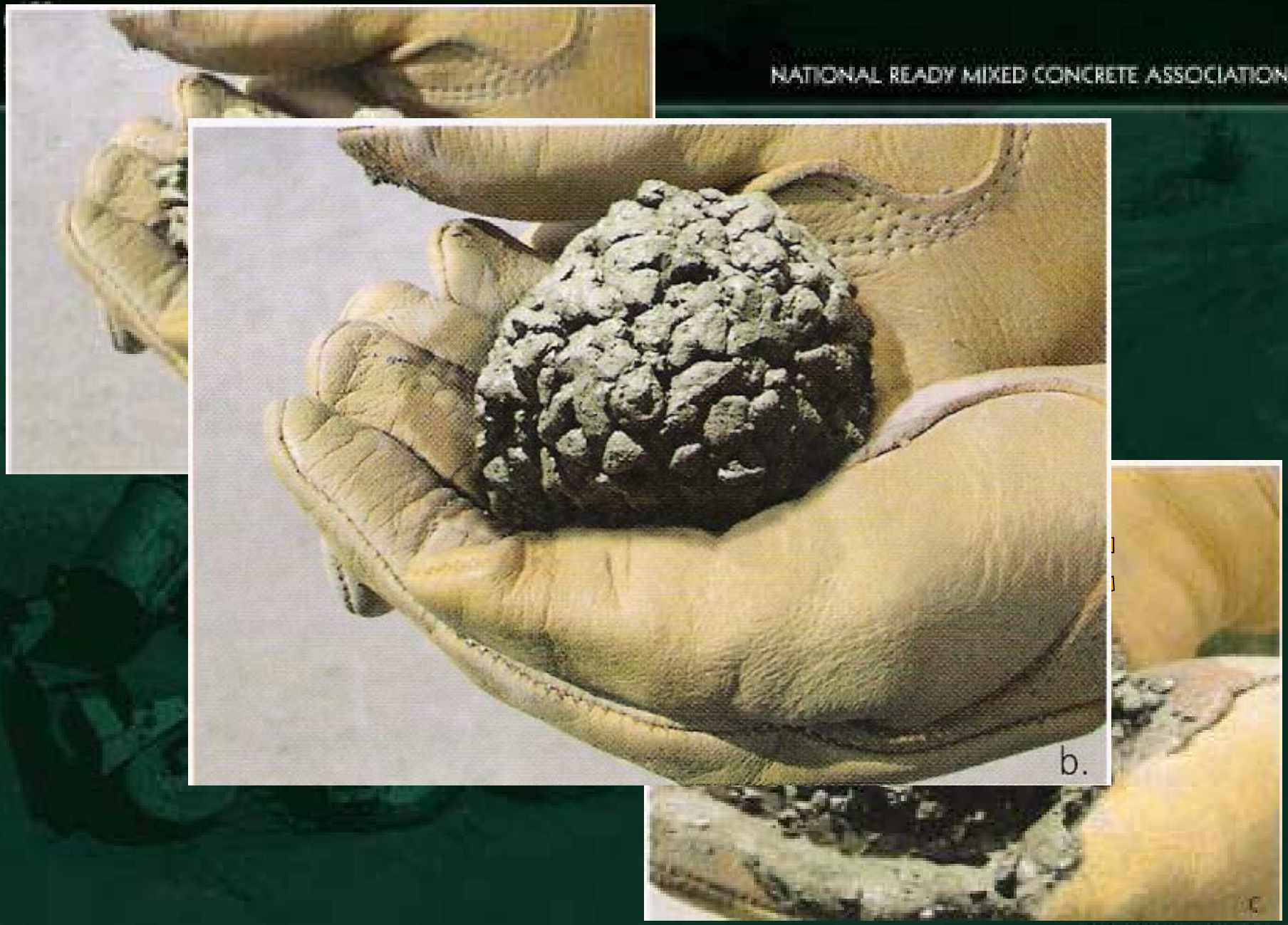
What is Pervious Concrete?

- 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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Pervious Concrete Properties

- 15% to 35% air void content
- 100 to 120 lbs/ft^3 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/min/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

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

- First 1” of rain
  - Contains contaminants
    - USGS study – Austin, TX
    - High concentration of polycyclic aromatic hydrocarbons (PAH)
    - Attributed to asphalt parking lot runoff
    - Runoff from asphalt-based sealants 10 times higher
    - Runoff from coal-tar based sealants 65 times higher
- EPA requires collection and treatment prior to release
  - Current practices missing high % of contaminants

First Flush

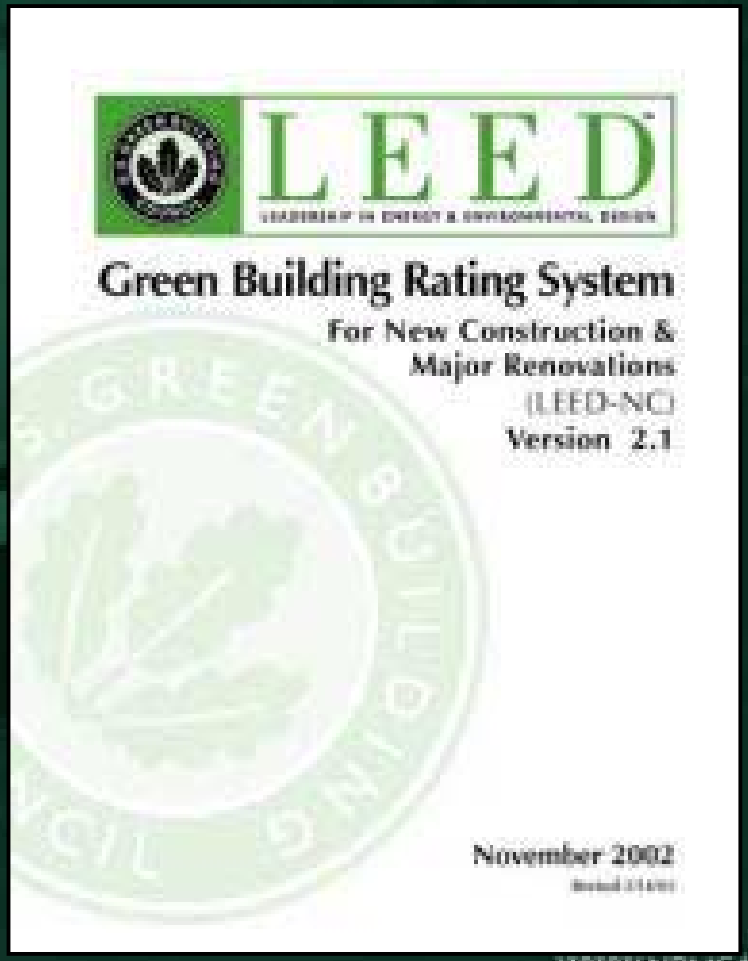
- Pervious concrete pavement reduces runoff
  - Cleaner first flush
  - Captured by void structure
  - Minimization of PAH
- Soil chemistry and biology will naturally treat water
  - Oil drips and other automotive pollutants are “attacked” by naturally occurring soil microbes

An EPA Approved BMP

- For stormwater pollution prevention
- Lower heat island effect
- Pervious concrete is eligible for one LEED credit point for the USGBC Green Building Rating System.

10 LEED

- **LEED:**
  - **Leadership in Energy & Environmental Design**
- **Green Building Rating System**
- **Developed by US Green Building Council**



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

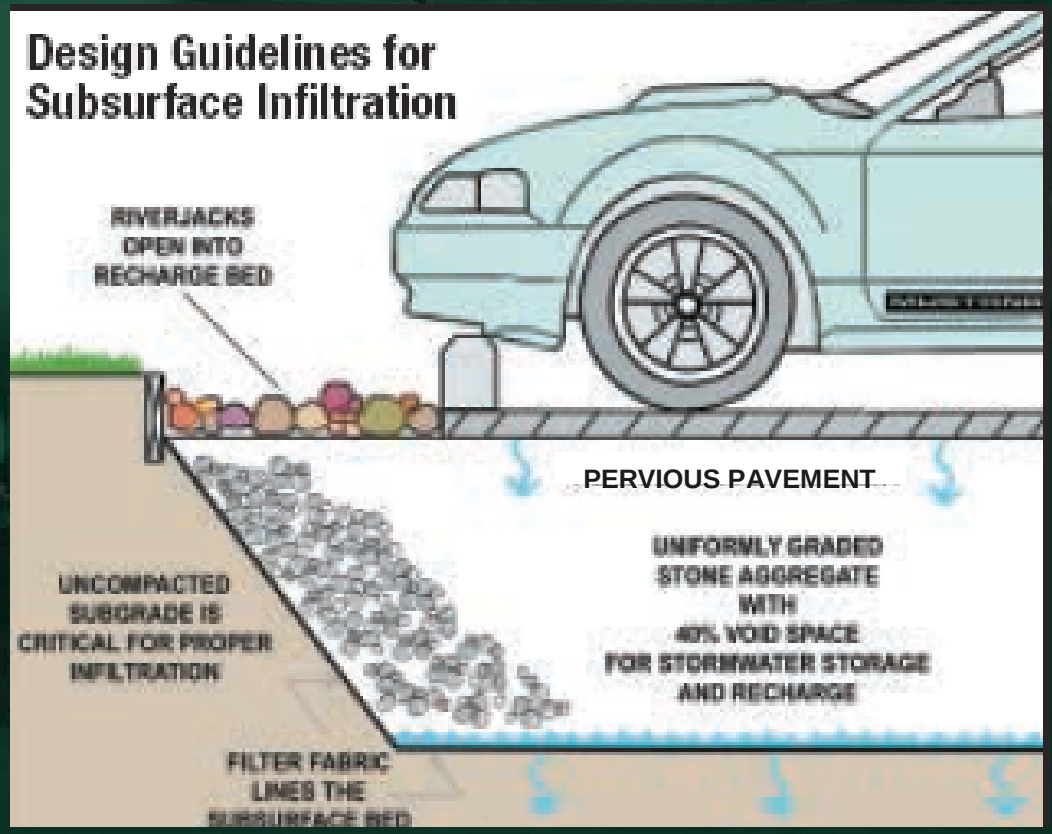
- Hydrological Design Considerations of pavement & related base materials (stormwater storage capacity)
- Mechanical Properties (load carrying capacity)
- Choose greater thickness of these needs
- Base design important to storage as well
- Design software is currently being developed

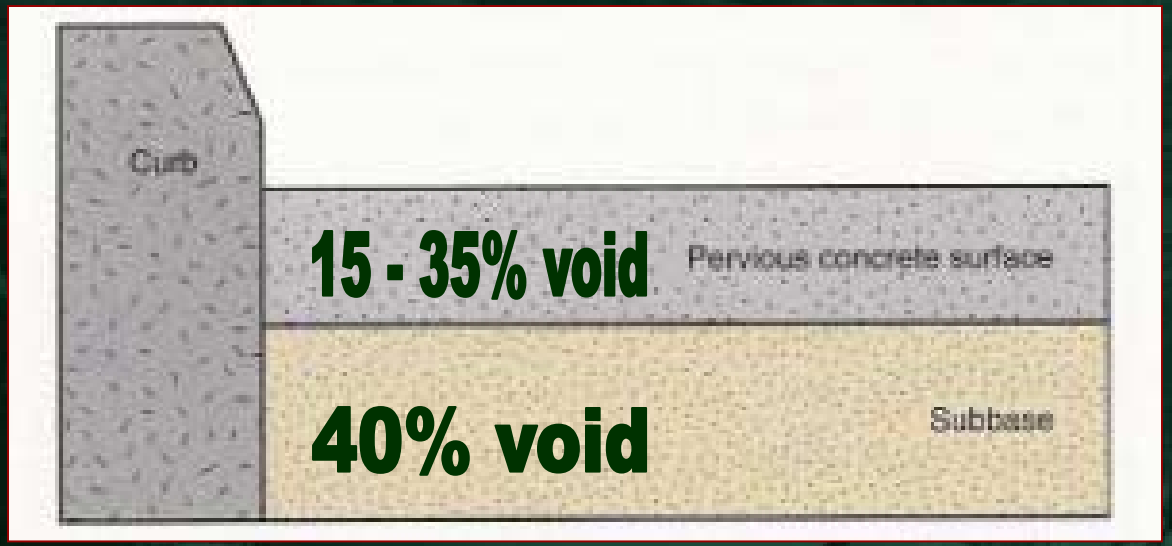
Infiltration Systems

- Developed in 1970's
  - Franklin Institute, Philadelphia, PA
  - Have been used for over 20 years
- Successful with concrete and asphalt

Infiltration System

- Porous Pavement
- Underlying, open-graded stone bed
  - 6-24” clean aggregate base
- Filter fabric minimizes migration of fines
- Perforated pipe to capture water & let it drain (optional)





- Underlying stone bed provides 40% void space
- 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
- Geotex prevents movement of fines into stone bed

Pervious Concrete Placement

- For fixed-form placement
  - Place and level forms to desired grade
  - Place ¾” furring strip on top of forms

Pervious Concrete Placement

- Place and screed pervious concrete level to furring strip.
- Remove furring strip and compact to desired final grade

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

Jointing

- Roughly ½ the shrinkage of normal concrete
- Pervious concrete parking areas are "***sometimes"*** placed with no joints***.
- If used, joints are typically placed every 20'
- Best practice is to tool joints
  - Sawing can cause raveling

“Pizza Cutter”

Curing

- Curing pervious concrete is perhaps more important than curing conventional concrete
- Without curing, surface will dry out and deteriorate easily
- Moist cure (7 days preferred)

Curing pervious concrete is <u>critical</u> due to the porosity and low W/C ratio

Durability of Pervious Concrete

- Directly related to proper placement
  - Maintain W/C ratio
  - Proper compaction of pervious surface
  - Proper curing is a must!

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

Types of Freeze

- Dry Freeze
  - **> 15** freeze-thaw cycles
  - Little precipitation
  - Pervious unlikely to be saturated
- Hard Dry Freeze
  - Same as above except ground stays frozen as a result of continuous average daily temperatures below freezing

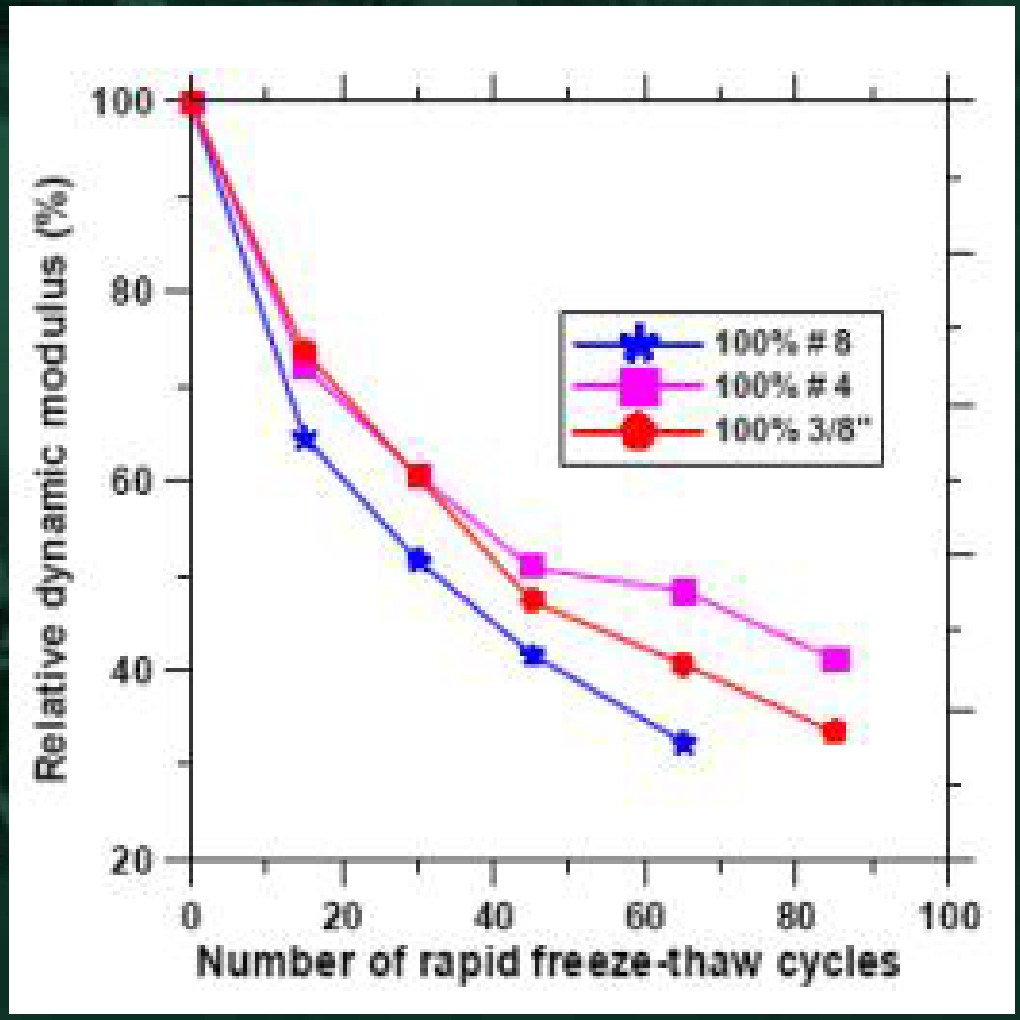
Types of Freeze

- Wet Freeze
  - **> 15** freeze-thaw cycles
  - Precipitation is common
  - Ground does not stay frozen
- Hard Wet Freeze
  - Ground stays frozen for prolonged period

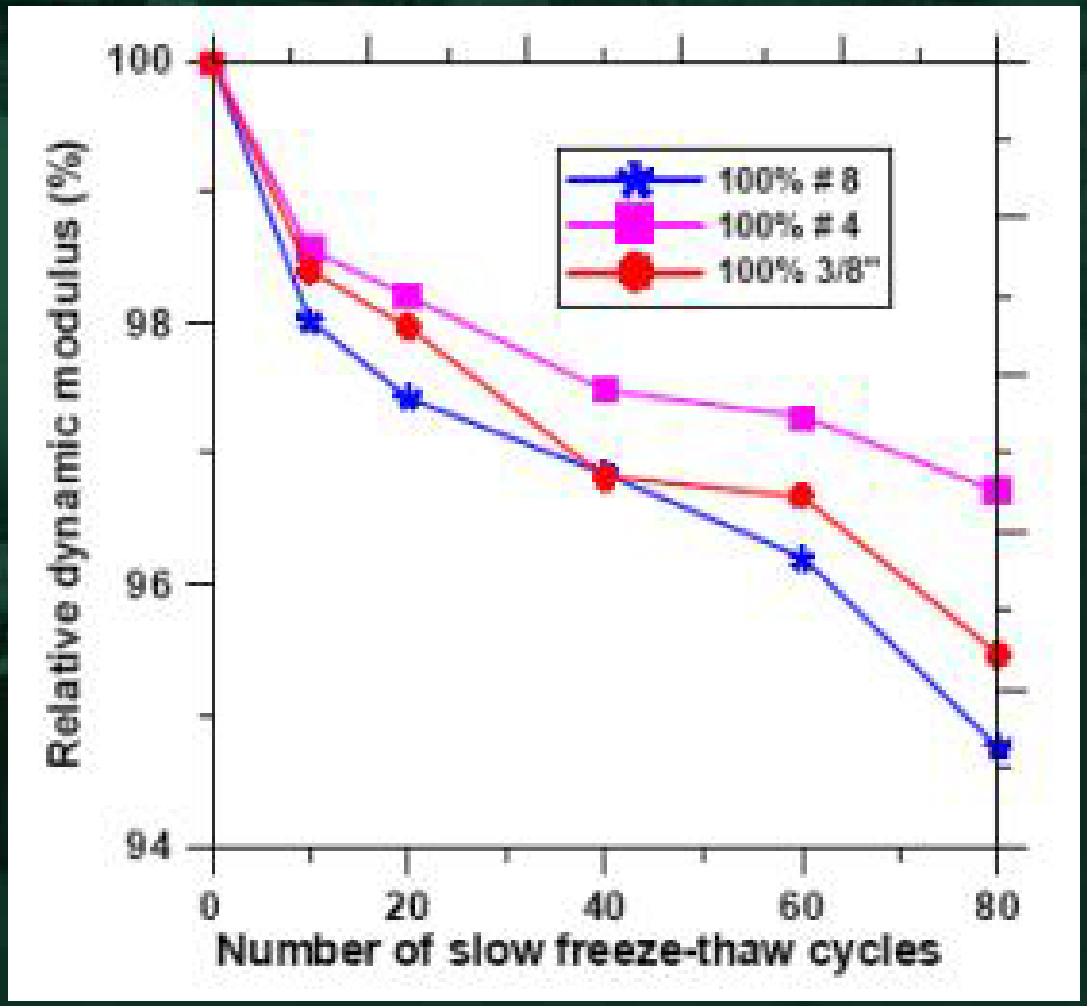
Purdue University

- Proportioned mixes with different aggregate sizes
- Conducted freeze-thaw study
  - ASTM C 666 Rapid Freeze-Thaw
  - Slow Freeze-Thaw
  - Samples were fully saturated

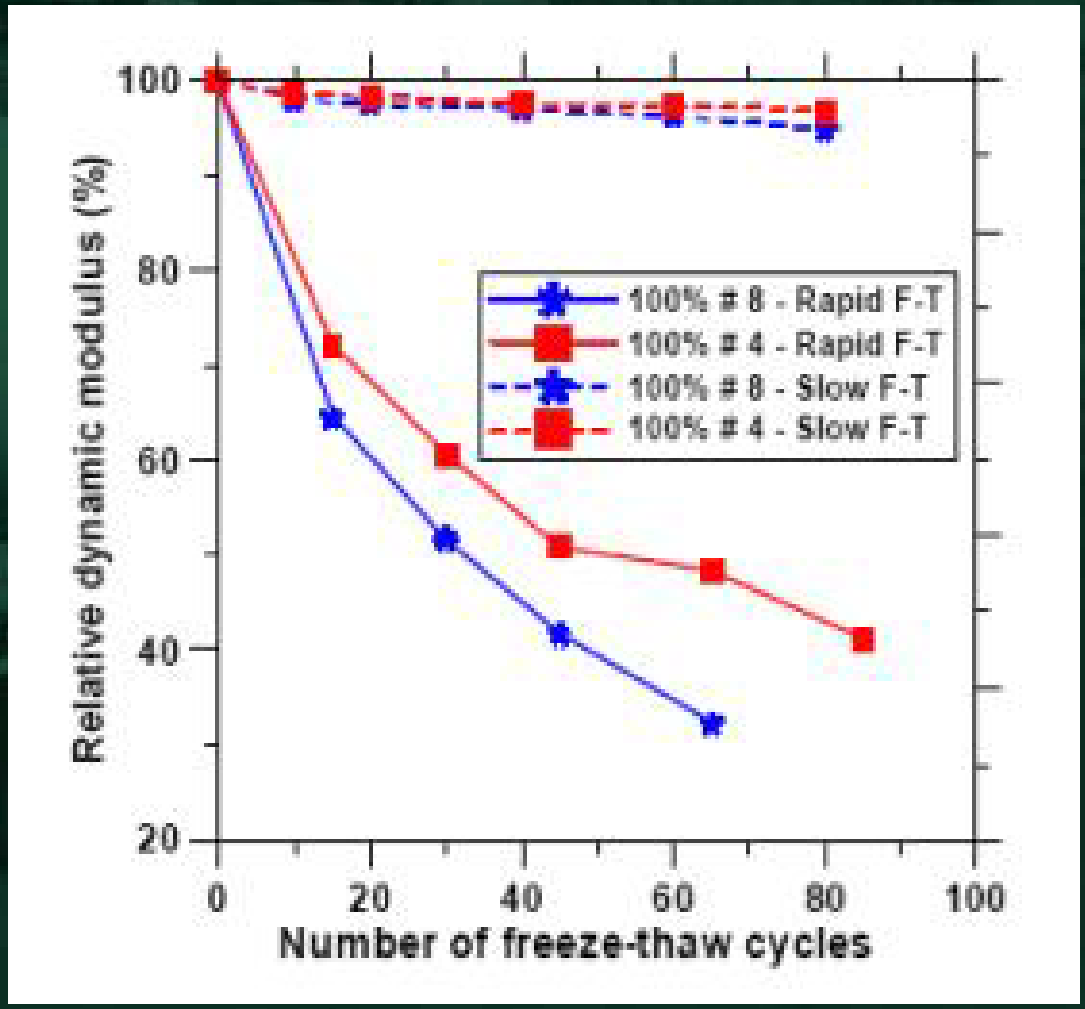
- Rapid F/T
  - 5-6 cycles per 24 hrs
- After 80 cycles
  - 60+% loss in dynamic modulus



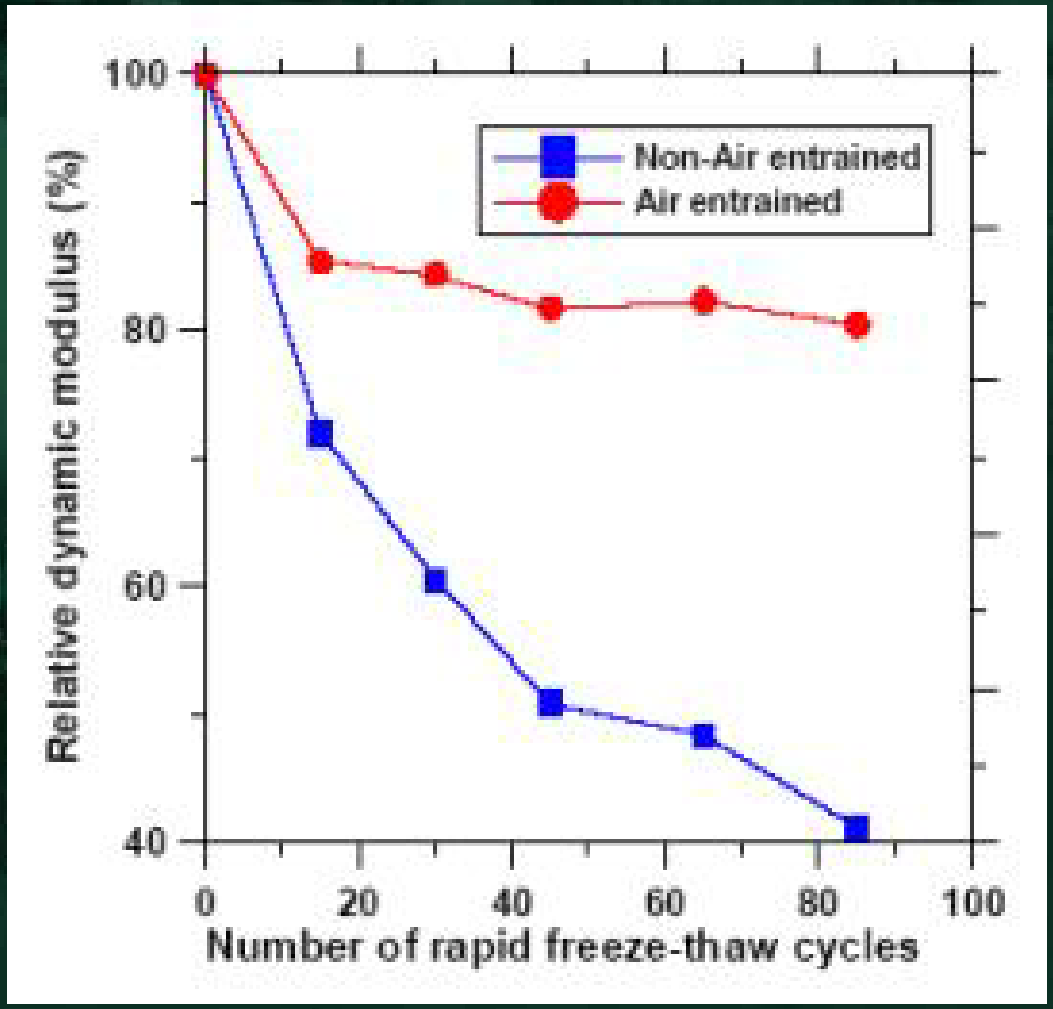
- Slow F/T
  - 1 cycle per 24 hrs
- < 6% loss of dynamic modulus



- Aggregate size does not affect F/T durability



- A/E reduces loss of dynamic modulus
- Non-air 60+% loss
- A/E 20% loss



Interpreting the Results

- Freezing rate has significant influence on dynamic modulus
- In practice, interconnected void system minimizes chance of total saturation
- Air entrainment enhances F/T resistance
- Actual performance should be superior to what was observed in lab

Snow Packing

- Anecdotal evidence suggests snow-covered pervious clears quicker than impervious surfaces
  - Less need for snowplowing
- Water drains through pavement into stone bed
- Sufficient void space to prevent heaving
- Water does not pond & re-freeze

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Denver, CO

Pervious Concrete

Conventional Asphalt

Sites directly across street

Photos: 5 min. differential max

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Denver, CO

Pervious Concrete

Conventional Asphalt

Sites directly across street

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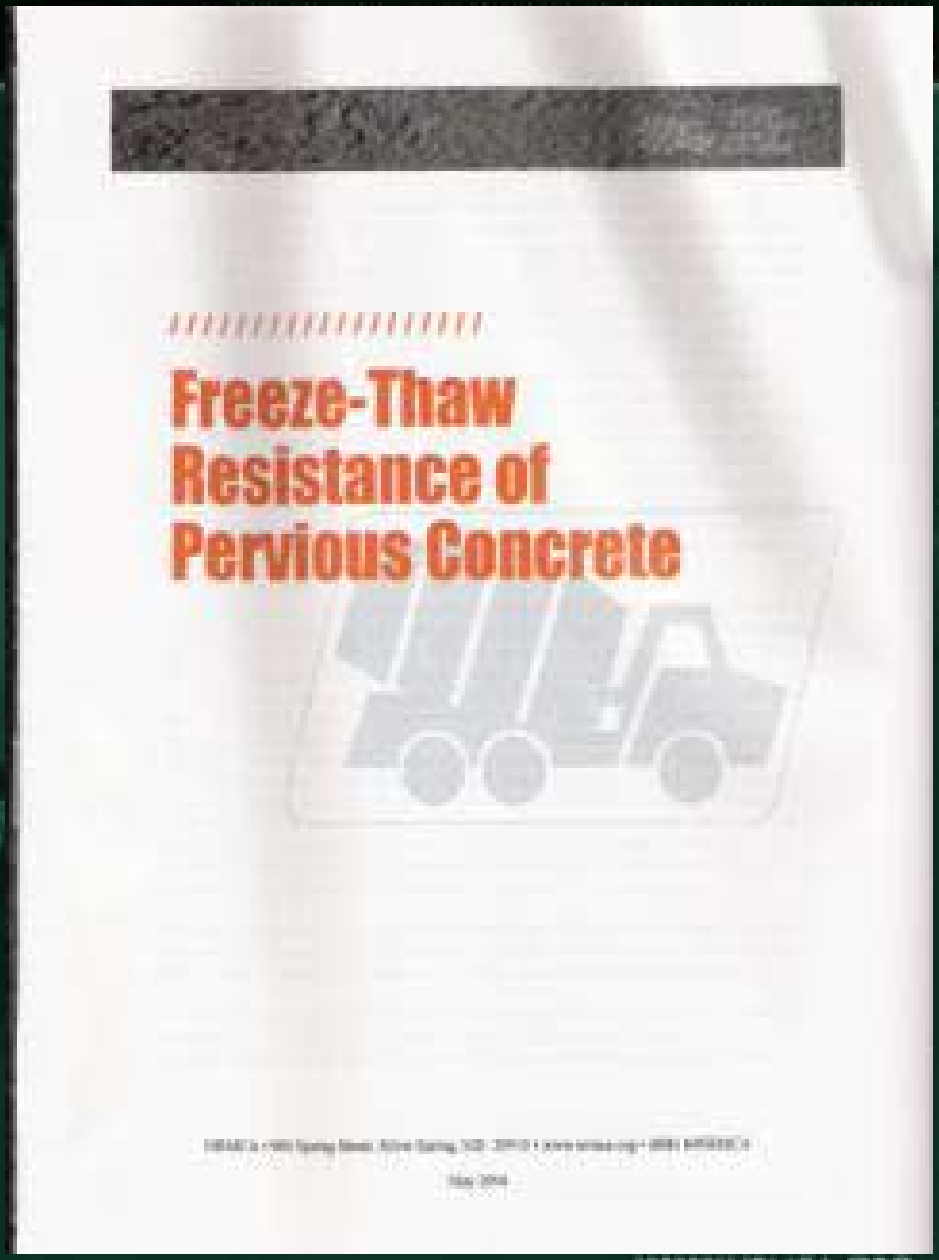
Study conducted by NRMCA

Results available at www.nrmca.org



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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

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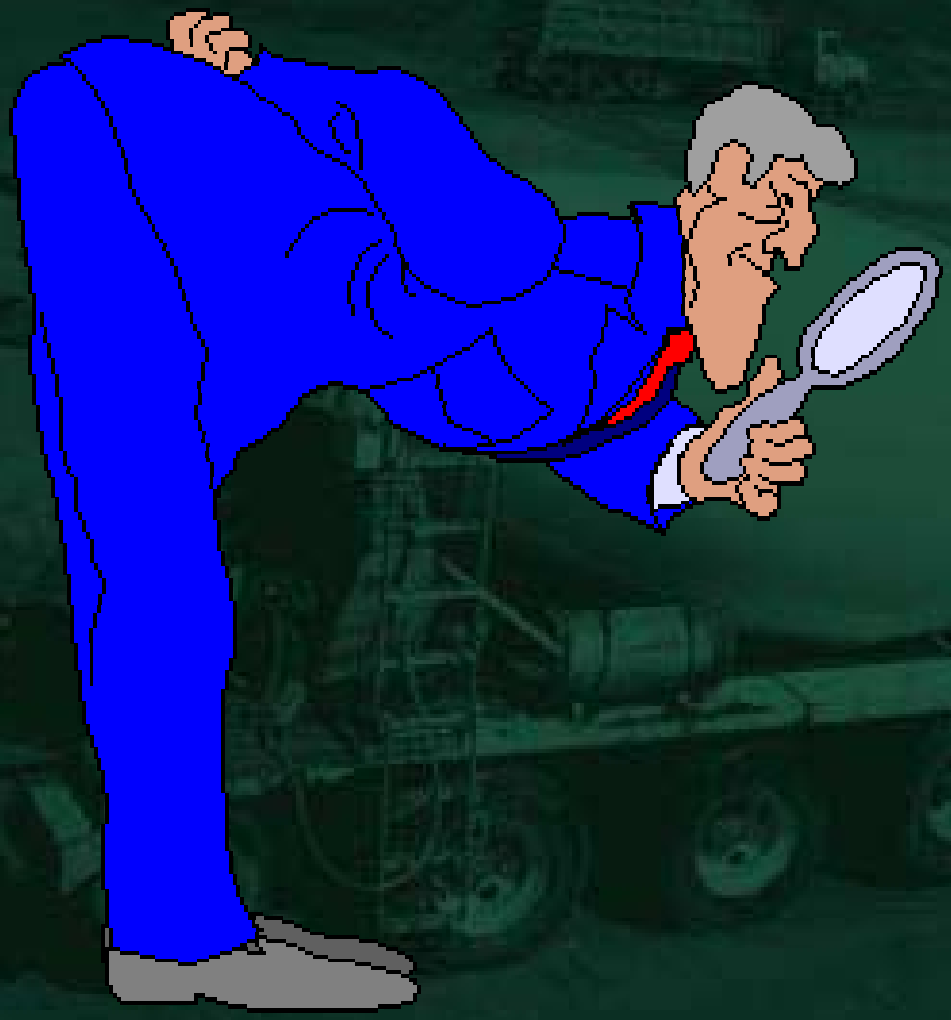

Let's Look at Some Recent Projects

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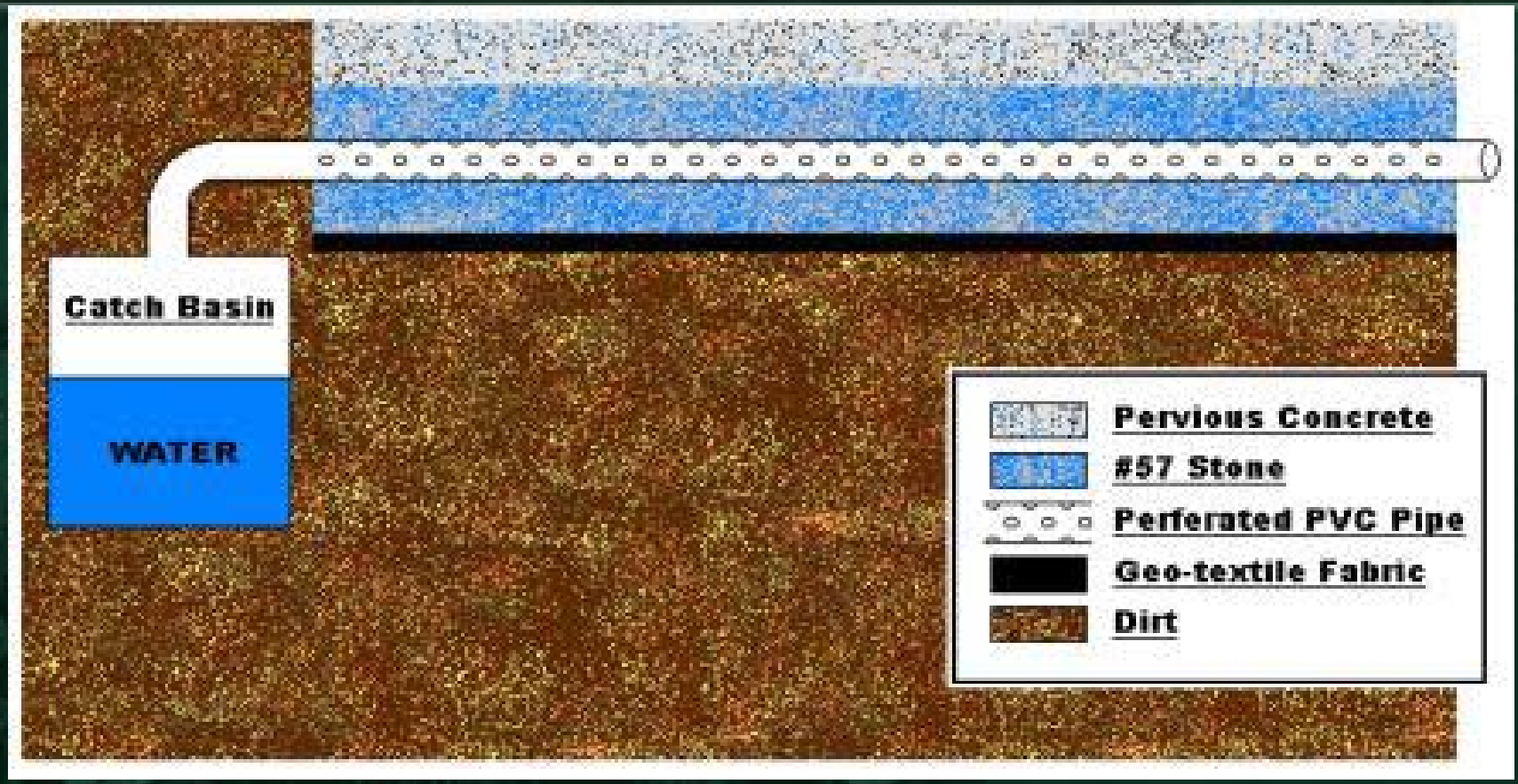
Sam's Club

Buford, GA


STOP

- **Finley Stadium**
  - Chattanooga, TN
- OCT, 1997
- At Issue:
  - Parking lot drainage & contaminated soils
- Total parking lot approximately 6 acres
- Size of pervious area
  - 10,000 ft²
  - 10 ½ ft width



- 6” stone subbase under entire parking lot
- 4” Pervious Concrete in parking areas
- 200,000 gal. holding capacity
- 400,000 gal catch basin

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Miller Park Pervious Concrete Parking Lot 2002

Pervious concrete saves trees by providing both **AIR** and **WATER** to the tree roots. This allows the trees to thrive and reduces tree-root lifting of the pavement.

- Centre County Welcome Center
  - State College, PA
- Placed 1999
- 4” Pervious Concrete on 6” Aggregate Base
- Hard Wet Freeze
  - 120 cycles/yr
  - Avg. below freezing for 90 days

- 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

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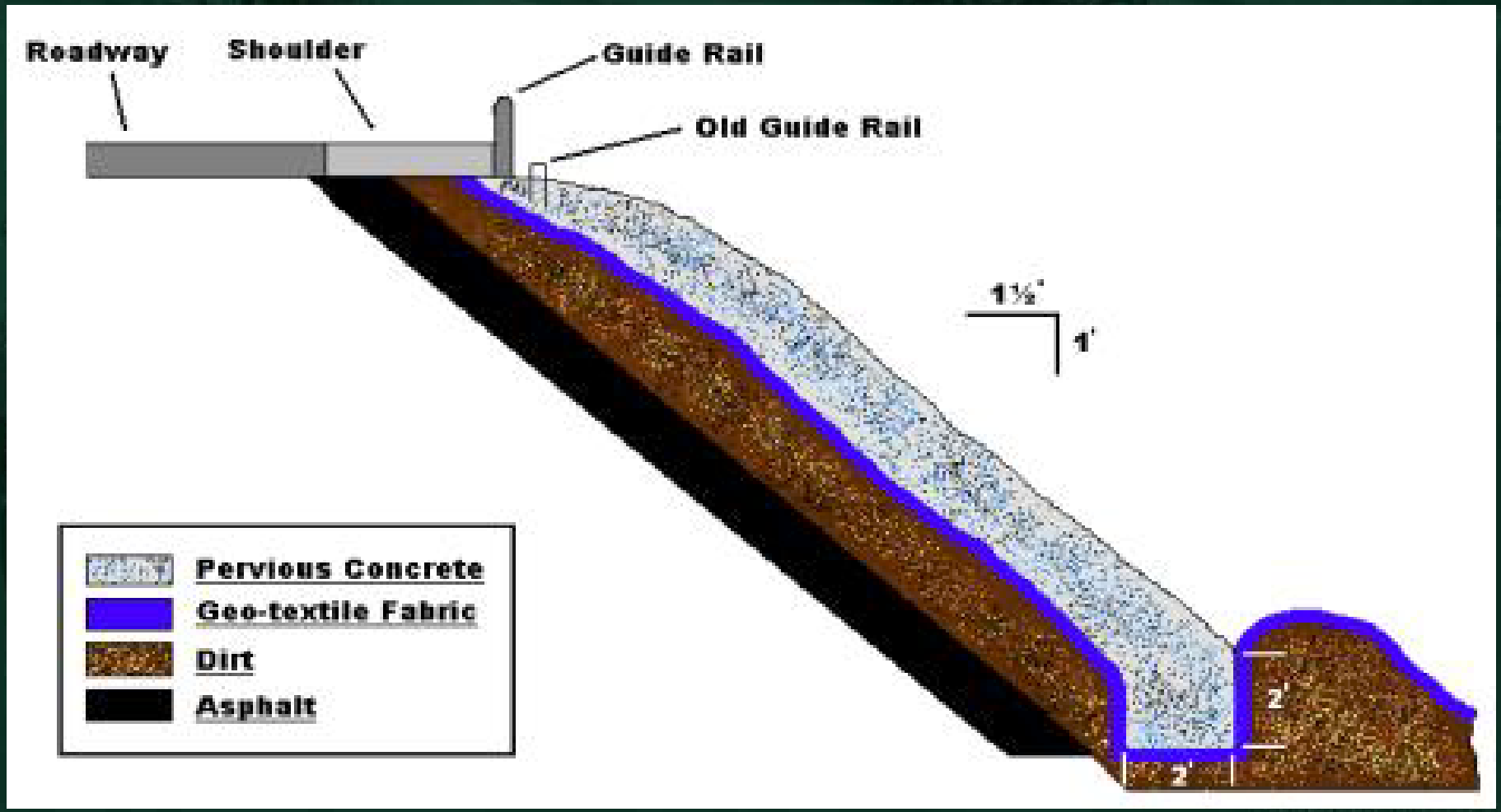

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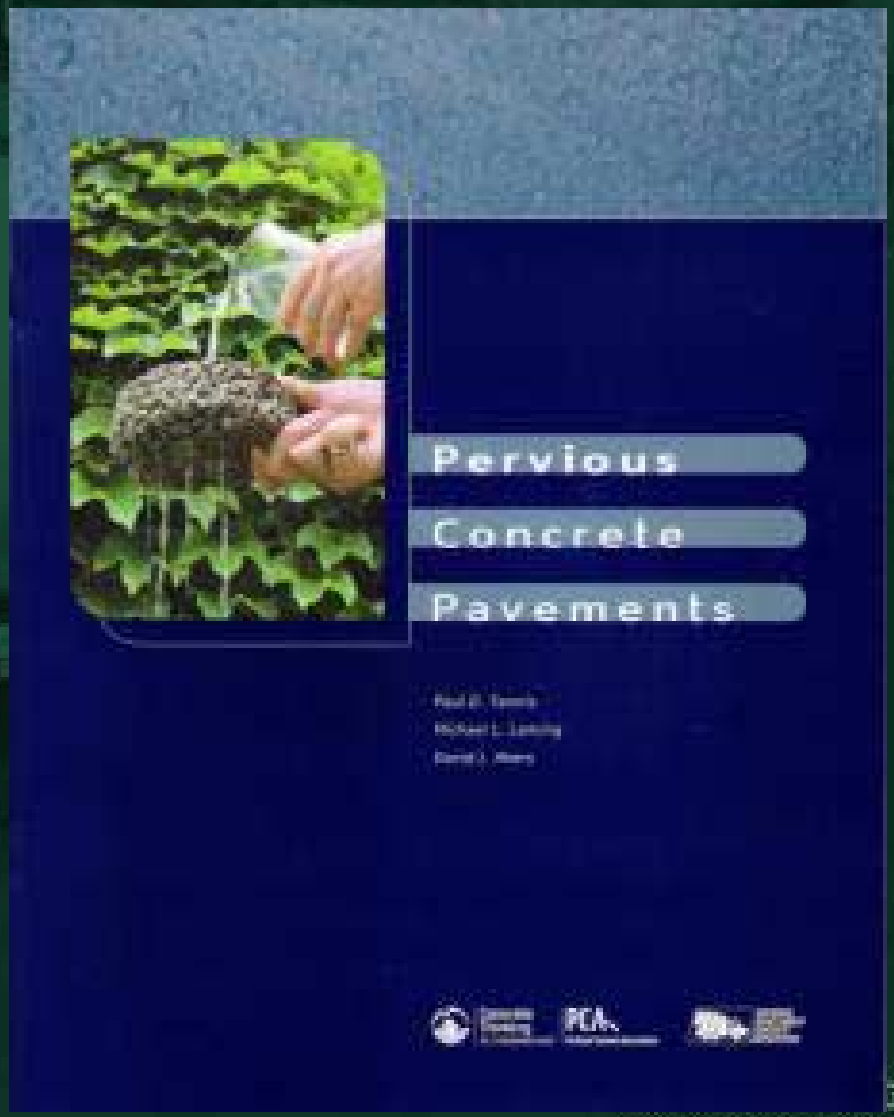
For further information . . .

- Available from NRMCA **www.nrmca.org**



Questions?

Thank You!

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