Design Conference 2008
PEOPLE MOVING PEOPLE

Performance of Pervious Pavements

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University of Central Florida
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Stormwater Management Academy
"Managed stormwater is good water."

H2O4U

UCF

Acknowledgements

- Rick Renna, Josh Boan, Larry Ritchie and David Sadler, Florida Department of Transportation
- Eric Livingston, Florida Department of Environmental Protection
- Ready Mixed Concrete Research Foundation
- Florida Concrete Products Association
- Michael Davy, CEMEX
- Kevin Bagnall, Flexipave
- Robert Bistor, Hubbard Construction
- Bill MeGrath, OldCastle Paver Systems

Outline of Presentation

- Overview
- Objectives of this Project
- Background
- Developments to Date
- Ongoing Research Studies
  - UCF Stormwater Laboratory Pavement Test Site
  - ERIK Infiltration Testing
  - Sediment Clogging Rehabilitation
- Future Directions
- Discussion

Overview

- US EPA Recognizes Pervious Pavements (Concrete) as a BMP for Stormwater Runoff
- Are being Considered as a part of the State Unified Stormwater Rule
- Initial Scope of UCF Studies (2002-2007)
  - Pervious Concrete Pavement
- Expanded Scope (2008)
  - Pervious Concrete Pavement (continued)
  - Pervious Pavers
  - Flexipave®
  - Pervious Asphalt

Overview – Pervious Concrete

- Pervious or no-fines Concrete – mixture of Coarse Aggregate, Portland Cement, Admixtures and Water
- Increased Porosity due to limited fines and 15-20% air voids
- Strong need for Current and Updated Assessment of Pervious Pavements

Overview – Flexipave

Firestone Specialty Product; www.firestonesp.com

- Pour-In-Place Paving System made with Recycled Automobile Tires
- Uses Aggregate, 3/8" rubber granules and a Urethane Binding Agent
- Open-pore design

Overview – Porous Asphalt

- Lower Concentration of Fines than Conventional Asphalt
- Allows water to drain through virtually imperceptible (to the eye) openings
- Underlying stone recharge beds

Overview – Pervious Pavers

- Interlocking Concrete or Brick Pavers
- Openings at the sides or edges allowing water to infiltrate
- Openings are filled with small size stone
- We are looking at two types (manufacturers) – Old Castle and Hanson AquaFlowFormpave

Background

- Replacement of Impervious Areas with Properly Designed and Constructed Pervious Paving Surfaces is Desirable
- Treating Pervious Pavement as a System with Pavement and Subsoil
- ACI Committee 522 (chaired by Matt Offenberg) has been formed to develop Guidelines for the use of Portland Cement Pervious Concrete
- Many Successful Paver Block Installations worldwide

Advantages and Disadvantages

- Advantages -
  - Recharge to Local Aquifer
  - Mimic predevelopment water budget
  - Potential Pollution Removal
  - Lower or No Need for Storm Sewers
  - Noise dampening
  - Heat island reduction (more trees)
- Disadvantages –
  - Lack of Proven Standards
  - Lack of Construction Experience and Expertise
  - Clogging Potential and Maintenance Requirements
  - Cold Weather Problems

DOT/WMD Issues

- Need for Credit (partial or total) for substituting pervious surfaces
- Based on Volume of water that can be Stored and allowed to Replenish the Aquifer and Evaporates
- Issues under investigation –
  - What are design issues– materials, dimensions, GWT?
  - What are proper construction methods?
  - What is the long term infiltration rate for the system?
  - What is effect on water quality?
  - Can vacuum sweeping or other operations be used to rejuvenate the pavements?

Previous Studies at UCF

- Researchers at the Academy Conducted Four Related Studies to Evaluate Performance of Pervious Concrete (PC) Pavements
- First Study –
  - Field Testing at Eight Parking PC Lots with average of 12 years
  - Created a Model to Simulate Hydraulic Function and Predict its Behavior under Various Rainfall Conditions over One Year Period
  - Developed a new field infiltration rate test using an Embedded Ring Infiltrometer Kit(ERIK) – monitor rates through the system (pavement and sub-base) over time

Previous Studies at UCF

- Second Study –
  - Investigated Construction and Maintenance Techniques used at sites in Florida, Georgia, and South Carolina
  - Suggested updates for Construction Specifications for locations with similar soil conditions
  - Evaluated two maintenance techniques – Vacuum Sweeping and Pressure Washing
- Third Study -
  - Studied the strength of Pervious Concrete
  - Confirmed Lower Compressive Strength than regular and should not be used for heavy vehicle loads

Previous Studies at UCF

- Fourth Study –
  - Evaluated the wear and infiltration of a pervious concrete shoulder along Interstate 4 near Orlando
  - Shoulder showed no visible wear from truck traffic
  - Infiltration rates remained constant during study period of one year
  - Tests of filtered water showed it to be equivalent to rainwater quality
  - It generated less runoff than the asphalt parking areas

Objectives of Current Phase

- Document Installation Practices and Standard Sections
- Establish Hydrological Design and Water Quality Parameters
- Record Operational Conditions resulting from Sediment Accumulation
- Document Vacuum Sweeping Results
- Establish Strength Parameters

ERIK Test for Infiltration Rates

ERIK Test for Infiltration Rates

ERIK Test – Typical Calculations

	Date	Description	Test #	Inch	hr	min	sec	total min	incr min	CUM MIN	In/hr
1	1/31/2008	4" Head	1	1	0	2	3	2.05	2.05	2.05	29.3
		PCRN		2	0	4	12	4.20	2.15	4.20	27.9
				3	0	6	15	6.25	2.05	6.25	29.3
				4	0	8	20	8.33	2.08	8.33	28.8
				5	0	10	52	10.87	2.53	10.87	23.7
			2	1	0	2	9	2.15	2.72	13.58	22.1
				2	0	4	52	4.87	2.15	15.73	27.9
				3	0	7	1	7.02	2.52	18.25	23.8
				4	0	9	32	9.53	2.47	20.72	24.3
				5	0	12	0	12.00	2.47	23.18	24.3
			3	1	0	2	16	2.27	2.27	25.45	26.5
				2	0	4	54	4.90	2.63	28.08	22.8
				3	0	7	14	7.23	2.33	30.42	25.7
				4	0	9	39	9.65	2.42	32.83	24.8
				5	0	13	11	13.18	3.53	36.37	17.0

n	15
Average	25.2
SD	3.2895
Avg + SD	28.5

Calculate Outliers

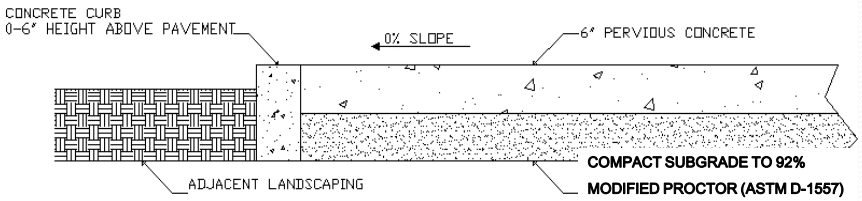
Installation of Pervious Pavements

- Location – Stormwater Academy Research Laboratory at UCF
- Adjoining the Erosion and Sediment Control Lab and Rainfall Simulator

Type	Area (sf)
Pervious Concrete	1500
Flexipave	1500
Pervious Pavers	660, 600
Porous Asphalt	1500

Pervious Concrete Pavement

Pervious Concrete Design Section



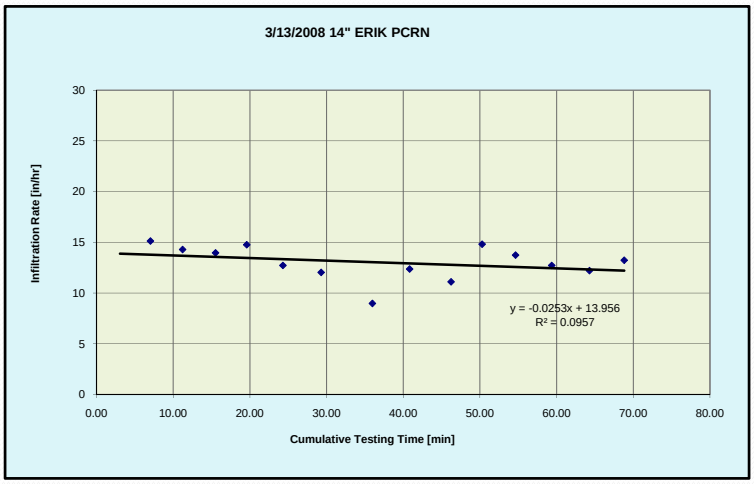
TYPICAL PERVIOUS CONCRETE PAVEMENT SECTION
N.T.S.

Pervious Concrete Pavement

Pervious Concrete Pavement

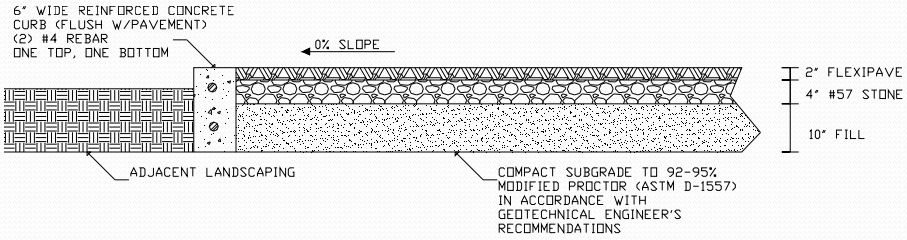
Pervious Concrete Pavement

Infiltration Rate of PC Pavement



Flexipave Pavement

Flexipave Design Section



SWLAB DRIVEWAY FLEXIPAVE SECTION
N.T.S.

Flexipave Pavement

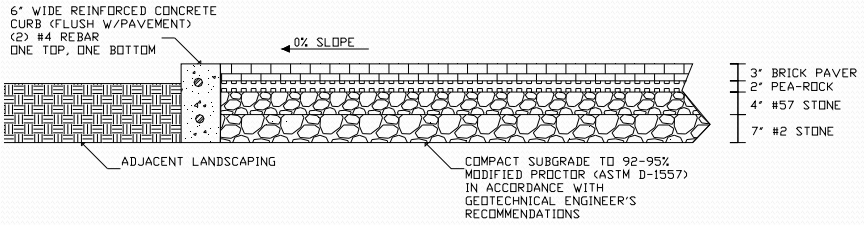
Flexipave Pavement

Flexipave Pavement

Flexipave Pavement

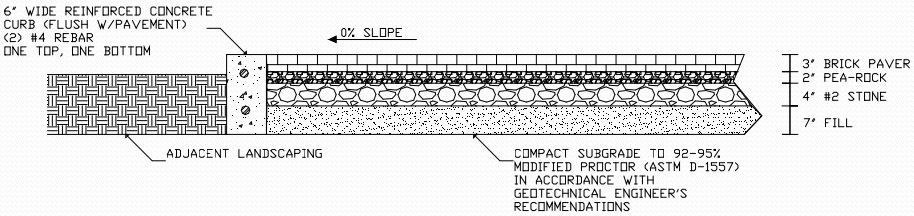
Pervious Brick Pavers

Pervious Pavers Design Section with Stone Reservoir



SWLAB DRIVEWAY BRICK PAVER SECTION (w/ ROCK RES.)
N.T.S.

Pervious Pavers Design Section without Stone Reservoir



SWLAB DRIVEWAY BRICK PAVER SECTION
N.T.S.

Pervious Brick Pavers

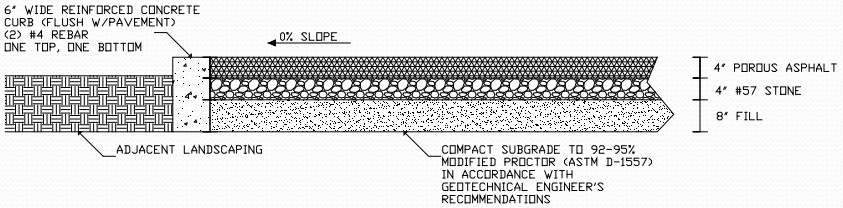
Pervious Brick Pavers

Pervious Brick Pavers

Water Quality Sampling

Porous Asphalt Pavement

Porous Asphalt Design Section



SWLAB DRIVEWAY POROUS ASPHALT SECTION
N.T.S.

Porous Asphalt Pavement

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Porous Asphalt Pavement

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Porous Asphalt Pavement

Rejuvenation Studies

- Sediment (sandy soil) was spread(1-2 inch of poorly graded sand) on top of the pavement surface
- Wet and compacted with Bobcat
- Conducted vacuum sweeping using Elgin MV Truck – 3-4 passes with some overlap
- Rate of sweeping under 2-4 mph (with 1" sediment) and under 5-7 mph for light sweep
- Followed by a second sweep over the entire area
- Measure infiltration rates pre and post-cleaning

Rejuvenation Studies - Wet

- Some of the studies were conducted on saturated pavement surfaces (PCRS)
- Surface wetting hindered the dislodging of particles due to suction forces
- Water was sprayed at 80 gallons/min until pavement was saturated and runoff occurred
- Surface was then vacuum swept
- It was noted that rate decreased after wet tests indicating finer particles may have migrated deeper and water was preventing the suction of these particles

Rejuvenation of Pervious Concrete

Rejuvenation of Flexipave

Rejuvenation of Pervious Pavers

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Rejuvenation of Porous Asphalt

Wetting of Surface

Compaction

Final Surface Ready for Sweeping

ERIK Testing Pre-Cleaning

Vacuum Sweeping - Truck

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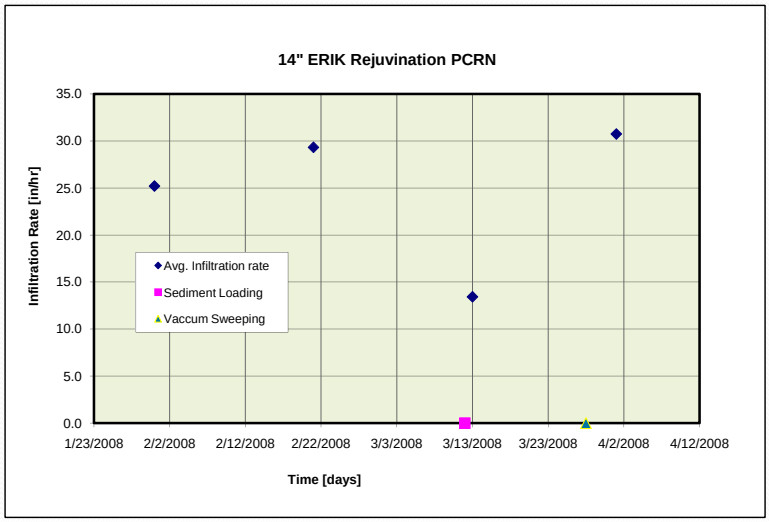
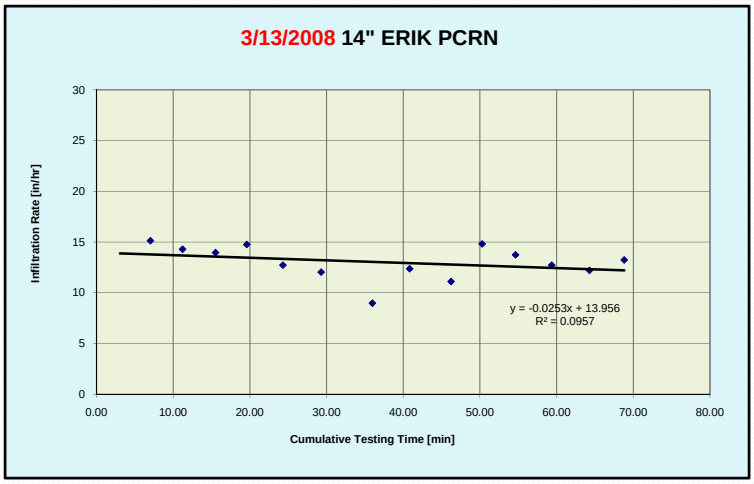
Vacuum Sweeping - Truck

Vacuum Sweeping - Wet

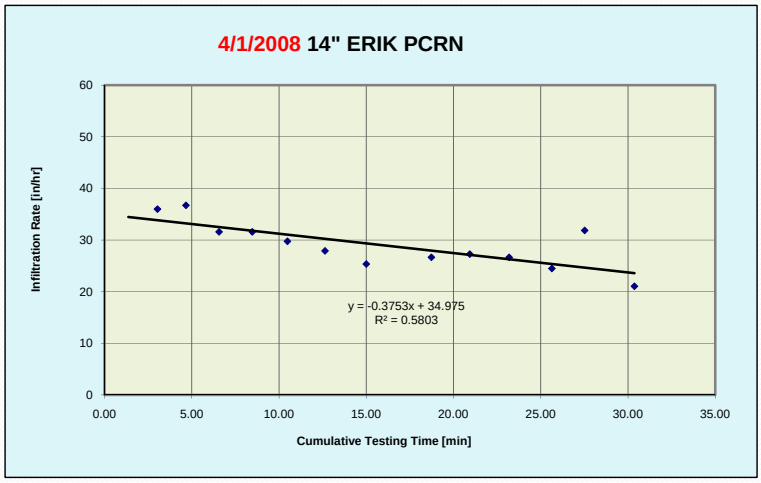
Rejuvenation of PC Pavement



Rejuvenation of PC Pavement



Rejuvenation of PC Pavement



Future Directions

- Rejuvenation studies conducted on all pavement types
- Analysis of Infiltration rates for all pavement types – pre and post cleaning
- Water quality studies
- Strength of pervious pavements

Thank you,
Questions?

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Stormwater Management Academy

"Managed stormwater is good water."

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