Minimizing Paving Costs with Sustainable Materials

for OTEC 2011

Presented by

Flexible Pavements OF OHIO

Impacts spur innovation

- Cost of petroleum and asphalt rising
- A societal desire to implement more sustainable practices to minimize the impact on the environment

Sustainability

- Definition: "practices that conserve resources in a manner that allow growth and development to be sustained for the long-term without degrading the environment".
- Controversy over what practices, products, materials actually meet the definition
- The simple approach:
- 3Rs, Reduce-Reuse-Recycle

Alternative Titles

- Saving money and saving the environment – No, (unintended consequences)
- Doing more with less
- Increasing performance and value - cost effectively, not just cutting cost
- The rest of this presentation will focus on the use of several asphalt paving technologies that improve the 3Rs of asphalt pavement and reduce the cost when implemented.

Asphalt is the Sustainable Pavement

- Reclaimed asphalt pavement (RAP) is 100% reusable
- Reclaimed asphalt shingles (RAS) –recycled waste
- Asphalt Rubber using ground tire rubber (GTR) - recycle
- Bio based and other additives – reduce use of petroleum
- Other waste products, recycled aggregates
- Warm Mix technology reduces energy and emissions at the plant and paving site
- Perpetual (long-lived) pavement – reduce reconstruction
- Porous pavements reduce stormwater runoff and pollution
- Visit: http://www.flexiblepavements.org/sustainable_pav.cfm

RAP

- Reclaimed Asphalt Pavement (RAP) is the big story in re-use and reduction.

RAP

- In Ohio nearly 100% of old asphalt pavement is reclaimed (RAP)

RAP

- Nearly 100% of the RAP is re-used to produce new asphalt concrete.

RAP

- Approximately 30% (average) of every ton of new asphalt concrete is reused RAP.
- Use of virgin materials are reduced.
- The numbers are getting better every year as equipment and technology improves.

Reclaimed Asphalt Shingles (RAS)

- Research and demonstration projects in the 1980’s and ‘90 showed RAS could be beneficially used in HMA.
- Some producers have routinely used manufacturer’s waste RAS in HMA.
- A 1997 FHWA/ODOT study showed use of shingle manufacturing waste could improve the performance characteristics of asphalt concrete

Background

- 10 million tons of asphalt Shingles enter waste stream each year
  - 1 million tons manufacturer waste
  - 9 million tons tear-offs or used Shingles
  - Third largest construction material waste
- The Asphalt Roofing Manufacturers Association (ARMA) analyzed a number of recycling options and identified HMA as the best use
  - Volume of waste used
  - Ease of recycling since Shingles composed of materials routinely used in HMA

Background

- Shingles typically contain:
  - Asphalt
    - Tear-offs contain 30 – 40% asphalt content
    - Manufacturer waste 18 – 22% asphalt
  - 40 to 60% hard rock granules and fillers
  - 1 to 12 % fiber and other materials

Background

- Why recycle shingles into asphalt concrete?
  - Economic benefits
    - Considerable cost savings per ton of HMA – replaces some of the most costly ingredient, asphalt binder
    - Reduces the use of virgin binder
  - Important where RAP is in insufficient supply
  - It's the right thing to do
    - Process can be engineered to provide asphalt mixtures with equivalent or improved performance
    - Keeps waste out of the landfill

Background

- Potential benefits from the use of Shingles in HMA include:
  - Improved resistance to pavement cracking
    - Due to reinforcement from fibers
  - Improved resistance to rutting
    - Due to fibers and increased stiffness of binder
  - Reduced costs for the production of HMA
    - Conservation of natural resources
  - Conservation of landfill space
    - Reduced costs for Shingle waste disposal
- Research continues on how best to incorporate RAS in asphalt concrete – use will likely grow with time.

ODOT RAS Specifications

- In 2010 and 2011 ODOT specifications were modified to permit the use of post-consumer, tear-off shingles in asphalt concrete
- Requires careful testing and processing to ensure no asbestos or other hazardous or deleterious material.

Ground tire rubber recycling

- Recycled GTR has been used in asphalt pavement mixtures in various ways
- As a aggregate replacement (dry process)
- And in a more beneficial method know as the ‘wet process’ or Asphalt Rubber
- Recycle 1000 tires per inch per mile

Ground tire rubber recycling

- In the wet process, GTR is reacted with the asphalt at the rate of 15 to 20% to cause swelling and partial digestion of the rubber particles into the asphalt.
- This type of blending can be done at the asphalt terminal or asphalt mixing plant.
- Properly done, this modification produces a beneficial improvement of the asphalt elastic properties similar to what we are used to seeing in polymer modification of asphalt.

GTR

- This blending of a large volume of rubber into the binder is a two-edged sword.
- It uses more recycled material, but
- It can be more problematic than polymer modification to produce consistent results.
- The detrimental effects of over processing are discussed in a White Paper, “The Effects of Digesting Crumb Rubber in Modified Binders (MB)”, available at http://rubberpavements.org/Library_Information/White_paper_Effects_of_Digestion_of_CR_ETG_Feb_15_2011.pdf

ODNR GTR Demo projects

- Several done in Ohio
- Lucas County, King Rd., 2004
- Franklin County, Frank Rd., 2006

More GTR information

- Chapman presentation, OAPC 2009, http://www.flexiblepavements.org/documents/OHIOGTR.pdf
- http://www.rubberpavements.org/faq.html

Bio-Derived Asphalt Binders

- Many companies and research institutions (Iowa State U) are busy developing alternative binders and supplements from crops, bio-mass or bio wastes.
- See the discussion at http://www.fhwa.dot.gov/pavement/materials/pubs/hif10002/ahpm04.cfm
- Also, Ecopave Australia and Road Oyl

Bio based additives

- An Ohio Company is developing a bio-oil from swine manure waste that can be used to extend and improve asphalt binder, based on laboratory results.
- The process is ready for full-scale production and testing.
- Nu-Vention Solutions, Inc BR2, http://nuventionsolutions.com/BR_2_Technology.html

Other recycled aggregates

- Steel slag
- Foundry sand
- Glass
- Wet bottom boiler slag

Other asphalt alternatives

- Sulfur making a comeback as an extender for asphalt due to WMA – Shell Thiopave
- See http://www.shell.com/home/content/sulphur/your_needs/products/in_roads/
- For an excellent report on the many Asphalt alternatives, see NAPA Special Report 198 at http://www.hotmix.org/images/stories/sr-198.pdf

What is Warm Mix Asphalt?

Several process have been developed to improve mixture workability allowing lower production and placement temperatures and requiring less energy, examples:

- WAM Foam – Shell/Kolo Veidekke
- Zeolite – Eurovia/Hubbard Construction
- Sasobit – Sasol Int./Moore and Munger
- Evotherm – MeadWestvaco
- Low Energy Asphalt – Fairco
- Foamed Asphalt- simple and effective, all manufacturers

Warm Mix Developed in Europe

- High energy costs
- Kyoto Treaty (reduce CO_2)

Why Warm Asphalt?

- Reduce production and laydown temperatures
- Reduce emissions
- Reduce energy costs
- Reduce aging of binder
- Other Benefits:
  - Cool weather paving (extend season)
  - Compaction aid for stiff mixes
  - Reduce bumps from pre-existing crack sealant

While achieving the same or better density!

Field Trials

World wide in dense-grade, SMA and OGFC

Numerous U.S. sections to date

Ohio DOT began in 2006

Field trials and Lab investigations show warm Mix is effective.

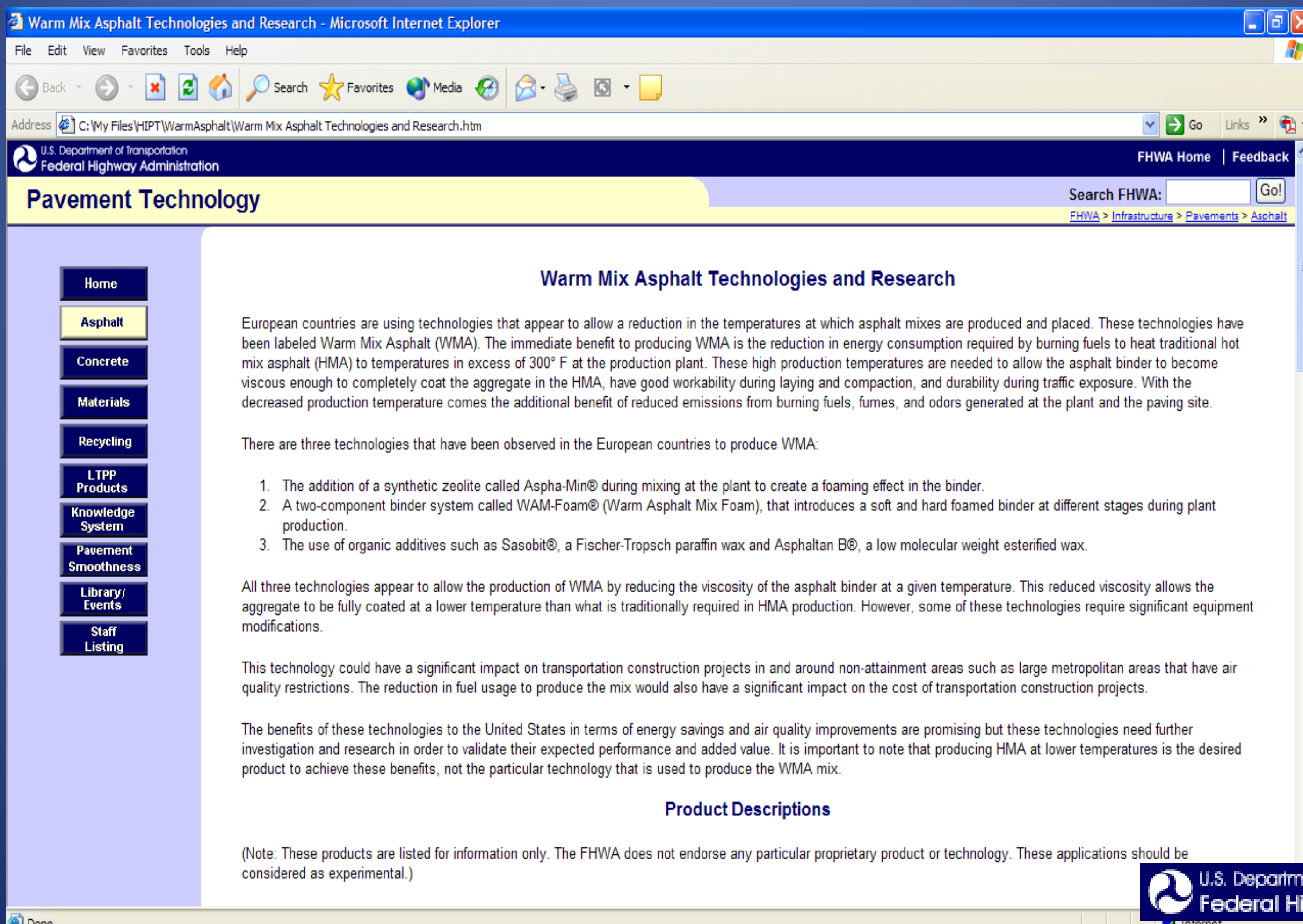
Permissive under ODOT specs since 2008

What Have We Learned?

- WMA technologies improve compaction, both in the lab and in the field
- While the technologies are still developing, it is clear that warm mix can produce pavements meeting service requirements
- Agencies should be prepared to allow warm mix if proposed by the contractor.

FHWA, Every Day Counts, WMA

www.fhwa.dot.gov/pavement/wma.htm



Warm Mix Asphalt Technologies and Research - Microsoft Internet Explorer

Address C:\My Files\HIPT\WarmAsphalt\Warm Mix Asphalt Technologies and Research.htm

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Warm Mix Asphalt Technologies and Research

European countries are using technologies that appear to allow a reduction in the temperatures at which asphalt mixes are produced and placed. These technologies have been labeled Warm Mix Asphalt (WMA). The immediate benefit to producing WMA is the reduction in energy consumption required by burning fuels to heat traditional hot mix asphalt (HMA) to temperatures in excess of 300° F at the production plant. These high production temperatures are needed to allow the asphalt binder to become viscous enough to completely coat the aggregate in the HMA, have good workability during laying and compaction, and durability during traffic exposure. With the decreased production temperature comes the additional benefit of reduced emissions from burning fuels, fumes, and odors generated at the plant and the paving site.

There are three technologies that have been observed in the European countries to produce WMA:

1. The addition of a synthetic zeolite called Aspha-Min® during mixing at the plant to create a foaming effect in the binder.
2. A two-component binder system called WAM-Foam® (Warm Asphalt Mix Foam), that introduces a soft and hard foamed binder at different stages during plant production.
3. The use of organic additives such as Sasobit®, a Fischer-Tropsch paraffin wax and Asphaltan B®, a low molecular weight esterified wax.

All three technologies appear to allow the production of WMA by reducing the viscosity of the asphalt binder at a given temperature. This reduced viscosity allows the aggregate to be fully coated at a lower temperature than what is traditionally required in HMA production. However, some of these technologies require significant equipment modifications.

This technology could have a significant impact on transportation construction projects in and around non-attainment areas such as large metropolitan areas that have air quality restrictions. The reduction in fuel usage to produce the mix would also have a significant impact on the cost of transportation construction projects.

The benefits of these technologies to the United States in terms of energy savings and air quality improvements are promising but these technologies need further investigation and research in order to validate their expected performance and added value. It is important to note that producing HMA at lower temperatures is the desired product to achieve these benefits, not the particular technology that is used to produce the WMA mix.

Product Descriptions

(Note: These products are listed for information only. The FHWA does not endorse any particular proprietary product or technology. These applications should be considered as experimental.)

Done

U.S. Department of Transportation
Federal Highway Administration

Other Sustainability Impacts

- Long-lived, Perpetual Pavement
- Porous asphalt pavement to improve water quality
- Carbon footprint
- Urban heat island

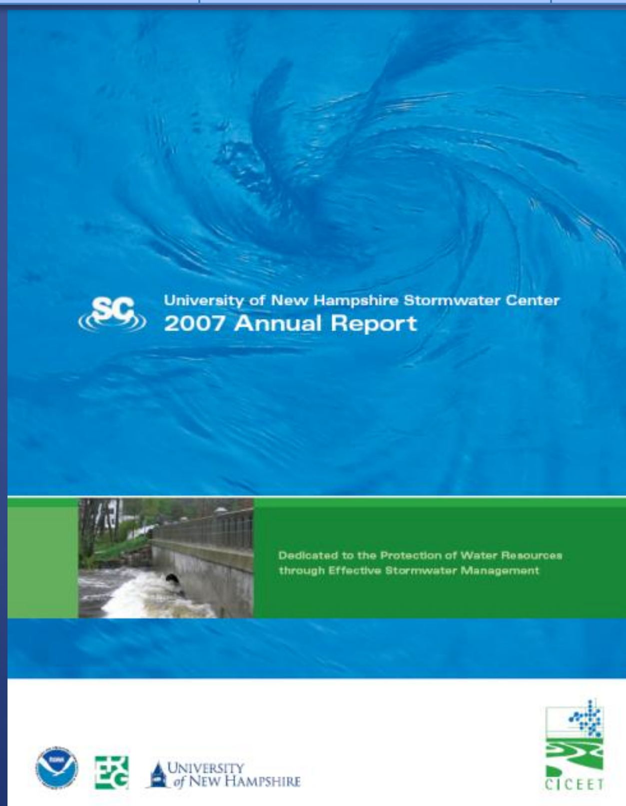
Reduce pavement reconstruction by using long-life pavement

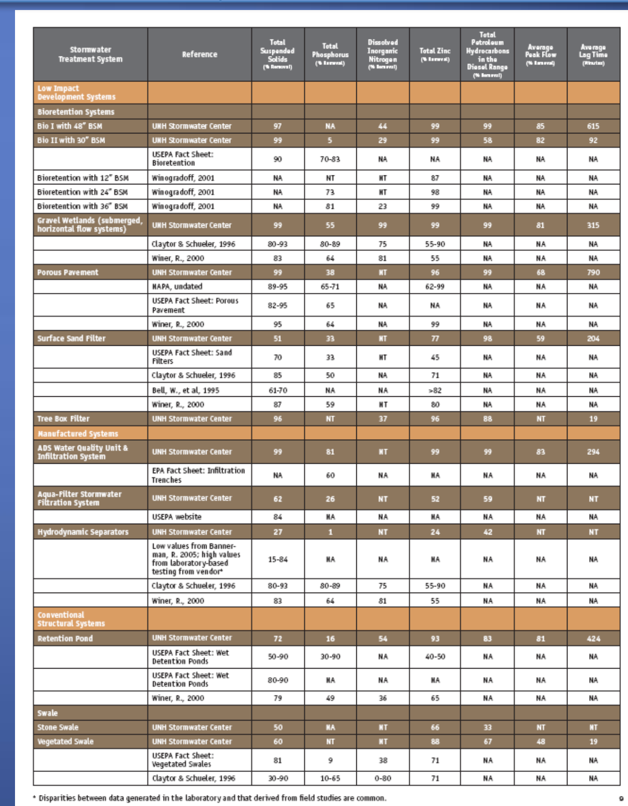
No asphalt base pavement on Ohio's Interstate system has ever required replacement or major rehabilitation – see the study: Economic Evaluation of Ohio's Flexible and Rigid Interstate Pavements at: http://www.flexiblepavements.org/images/ecoeval.pdf

The **Perpetual Pavement Concept** – base that lasts indefinitely with just surface maintenance

Porous Pavement Water Quality

Total Suspended Solids (% Removal)	Total Phosphorus (% Removal)	Total Zinc (% Removal)	Total Petroleum Hydrocarbons in the Diesel Range (% Removal)
99	38	96	99





Stormwater Treatment System	Reference	Total Suspended Solids (% Removal)	Total Phosphorus (% Removal)	Dissolved Inorganic Nitrogen (% Removal)	Total Zinc (% Removal)	Total Petroleum Hydrocarbons in the Diesel Range (% Removal)	Average Peak Flow (% Removal)	Average Lag Time (Minutes)
Low Impact Development Systems								
Bioretention Systems								
Bio I with 48" BSM	UNH Stormwater Center	97	NA	44	99	99	85	615
Bio II with 30" BSM	UNH Stormwater Center	99	5	29	99	58	82	92
	USEPA Fact Sheet: Bioretention	90	70-83	NA	NA	NA	NA	NA
Bioretention with 12" BSM	Winogradoff, 2001	NA	NT	NT	87	NA	NA	NA
Bioretention with 24" BSM	Winogradoff, 2001	NA	73	NT	98	NA	NA	NA
Bioretention with 36" BSM	Winogradoff, 2001	NA	81	23	99	NA	NA	NA
Gravel Wetlands (submerged, horizontal flow systems)	UNH Stormwater Center	99	55	99	99	99	81	315
	Claytor & Schueler, 1996	80-93	80-89	75	55-90	NA	NA	NA
	Winer, R., 2000	83	64	81	55	NA	NA	NA
Porous Pavement	UNH Stormwater Center	99	38	NT	96	99	68	790
	NAPA, undated	89-95	65-71	NA	62-99	NA	NA	NA
	USEPA Fact Sheet: Porous Pavement	82-95	65	NA	NA	NA	NA	NA
	Winer, R., 2000	95	64	NA	99	NA	NA	NA
Surface Sand Filter	UNH Stormwater Center	51	33	NT	77	98	59	204
	USEPA Fact Sheet: Sand Filters	70	33	NT	45	NA	NA	NA
	Claytor & Schueler, 1996	85	50	NA	71	NA	NA	NA
	Bell, W., et al, 1995	61-70	NA	NA	>82	NA	NA	NA
	Winer, R., 2000	87	59	NT	80	NA	NA	NA
Tree Box Filter	UNH Stormwater Center	96	NT	37	96	88	NT	19
Manufactured Systems								
ADS Water Quality Unit & Infiltration System	UNH Stormwater Center	99	81	NT	99	99	83	294
	EPA Fact Sheet: Infiltration Trenches	NA	60	NA	NA	NA	NA	NA
Aqua-Filter Stormwater Filtration System	UNH Stormwater Center	62	26	NT	52	59	NT	NT
	USEPA website	84	NA	NA	NA	NA	NA	NA
Hydrodynamic Separators	UNH Stormwater Center	27	1	NT	24	42	NT	NT
	Low values from Bannerman, R. 2005; high values from laboratory-based testing from vendor*	15-84	NA	NA	NA	NA	NA	NA
	Claytor & Schueler, 1996	80-93	80-89	75	55-90	NA	NA	NA
	Winer, R., 2000	83	64	81	55	NA	NA	NA
Conventional Structural Systems								
Retention Pond	UNH Stormwater Center	72	16	54	93	83	81	424
	USEPA Fact Sheet: Wet Detention Ponds	50-90	30-90	NA	40-50	NA	NA	NA
	USEPA Fact Sheet: Wet Detention Ponds	80-90	NA	NA	NA	NA	NA	NA
	Winer, R., 2000	79	49	36	65	NA	NA	NA
Swale								
Stone Swale	UNH Stormwater Center	50	NA	NT	66	33	NT	NT
Vegetated Swale	UNH Stormwater Center	60	NT	NT	88	67	48	19
	USEPA Fact Sheet: Vegetated Swales	81	9	38	71	NA	NA	NA
	Claytor & Schueler, 1996	30-90	10-65	0-80	71	NA	NA	NA

* Disparities between data generated in the laboratory and that derived from field studies are common.

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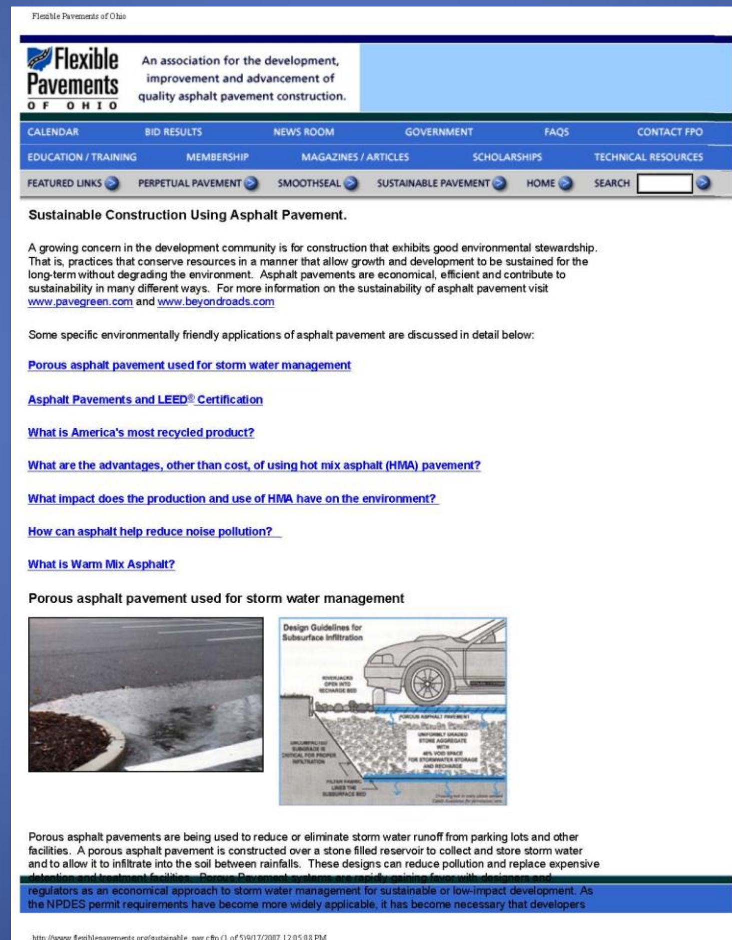
Carbon Footprint

- Carbon footprint is a concern related to climate change
- See the article/analysis by Dr. Brian Prowell at http://www.flexiblepavements.org/documents/IowaasphaltGreen.pdf
- Analysis indicates asphalt pavement has approx. 50% the carbon footprint of other pavement types.

Urban Heat Island

- Is an energy use issue?
- Ohio: 10 heating to one cooling degree-days (6000/600), snow and ice removal
- Does being warmer help more than hurt?
- Not a simple reflectivity issue (albedo or solar reflectance index, SRI)
- If solar flux is reflected, reflected onto what?
- Porous pavements cooler than dense
- Additional science needed on this issue

For more Information on Sustainable Pavement visit:
http://www.flexiblepavements.org/sustainable_pav.cfm



Flexible Pavements of Ohio

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An association for the development, improvement and advancement of quality asphalt pavement construction.

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Sustainable Construction Using Asphalt Pavement.

A growing concern in the development community is for construction that exhibits good environmental stewardship. That is, practices that conserve resources in a manner that allow growth and development to be sustained for the long-term without degrading the environment. Asphalt pavements are economical, efficient and contribute to sustainability in many different ways. For more information on the sustainability of asphalt pavement visit www.pavegreen.com and www.beyondroads.com

Some specific environmentally friendly applications of asphalt pavement are discussed in detail below:

Porous asphalt pavement used for storm water management

Asphalt Pavements and LEED® Certification

What is America's most recycled product?

What are the advantages, other than cost, of using hot mix asphalt (HMA) pavement?

What impact does the production and use of HMA have on the environment?

How can asphalt help reduce noise pollution?

What is Warm Mix Asphalt?

Porous asphalt pavement used for storm water management

Porous asphalt pavements are being used to reduce or eliminate storm water runoff from parking lots and other facilities. A porous asphalt pavement is constructed over a stone filled reservoir to collect and store storm water and to allow it to infiltrate into the soil between rainfalls. These designs can reduce pollution and replace expensive detection and treatment facilities. Porous Pavement systems are rapidly gaining favor with designers and regulators as an economical approach to storm water management for sustainable or low-impact development. As the NPDES permit requirements have become more widely applicable, it has become necessary that developers

http://www.flexiblepavements.org/sustainable_pav.cfm (1 of 5)9/17/2007 12:05:08 PM

NAPA Sustainability Publications

- Find at http://store.hotmix.org/index.php
- Black and Green Report, SR-200 (digital version at http://www.sustainableasphalt.turn-page.com/
- Benefits of Asphalt, PS-35
- Porous Asphalt Pavement, PS-33
- Asphalt Pavement and the LEED Green Building System, PS-32
- Warm Mix, PS-30
- Clean Air and Cool Cities http://www.hotmix.org/images/stories/clean_air_and_cool_cities.pdf
- http://asphaltroads.org/Environment

Questions?

- About
- Sustainabilty in Asphalt Pavements?

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