ASPHALT: a contractor’s perspective on the environmentally sustainable pavement

Greening the Blacktop
ASPHALT: the environmentally sustainable pavement

- Stormwater management / porous pavement
- UHI and reflective asphalt pavements
- Recycled materials / RAP
- Env. Performance and Carbon Footprints
- Warm Mix Asphalt
early 1900s HMA plant
urban development
stormwater management

RAINFALL 45"/YR

2" EVAPORATIVE LOSS FROM IMPERVIOUS SURFACES

REDUCED INFILTRATION THROUGH REGRADED AND COMPACTED SOILS IN GRASSES

0" OF INFILTRATION UNDER IMPERVIOUS SURFACES

43" RUNOFF FROM IMPERVIOUS COVER

REDUCTION IN BASE FLOW BY 15"/YR UNDER IMPERVIOUS SURFACES
stormwater management
Porous Pavement with Recharge Bed

River Jacks Open Into Recharge Bed

Porous Asphalt

Geotextile Membrane

Stone Bed w/ 40% Voids for Storage/Recharge

stormwater management
Standard Pavement  Porous Pavement

Univ. NC: add’l parking lot constructed ca. 2002

stormwater management
Benefits of Porous Pavement

**Economic**
- Reduces/Eliminates the land space consumed by conventional detention facilities
- Helps prevent excessive flooding and minimizes need for control measures

**Aesthetic**
- Eliminates the need for unsightly detention basins
- Preserves areas such as woods/open space

**Environmental**
- Limits peak stormwater discharge and improves water quality of any runoff
- Reduces amount of impervious surfaces
Dense-graded asphalt pavements were historically the standard for roadways
- Provides structure, strength, and smoothness
- Smoothness can cause water overspray

Open-graded Friction Courses (OGFC) developed to minimize overspray
- Developed in the late 1940s (airports)
- Pavement contains greater air voids
- Thin OGFC pavement above dense-graded mat

OGFC Highly successful in minimizing accidents
- Calif-DOT identified a 50% decrease in deaths and 20% decrease in accidents after Hwy re-paved using OGFC
- Other state statistics similar

safer pavements
Spray Reduction: OGFC on Freeway

safer pavements
Vehicles on highways generate a significant amount of noise.

Noise from the tire / pavement interface accounts for over 75% of the vehicle noise.

Sound-walls are expensive and are only somewhat effective if placed in the line-of-sight:
- They reduce noise minimally and only over certain distances from the roadway.
- Sound-walls can increase UHI effects because they decrease air movement across pavement surface.

Traffic Noise can be significantly reduced using Open-Graded Friction Courses (OGFC).
Noise Reduction: AR-OGFC on Highway

SR 202W
11/7/03 106 dB(A)

quieter pavements
Little vegetation or evaporation causes cities to remain warmer than the surrounding countryside.
Pavement Temperatures vs. Albedos

- San Ramon, 8/7/98
- Berkeley, 9/13/96

myth or reality?
Location: University Dr., Tempe, AZ
Time: 2:30pm, May 15, 2007

Albedo = 0.192
Surf. Temp = 131, 131.5, 130 (°F)
Age = >5 years
Traffic = light foot, cart and bicycle traffic

Albedo = 0.090
Surf. Temp = 129.9, 130.2, 128.4 (°F)
Age = >5 years
Traffic = constant traffic

Albedo = 0.036
Surf. Temp = 146.8, 143.3, 147.4 (°F)
Age = 3 days
Traffic = no traffic
Location: University Dr., Tempe, AZ
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cooler pavements
Interstate

Highway

mountain range

cooler pavements
Below grade w/ sound walls

asphalt-based OGFC over reflective pavement

Above grade w/ landscape

Below grade w/ sound walls

Airport: 23-inch thick reflective pavement

cooler pavements
Cool Pavements

- Denotes link to glossary definition

There is no official standard or labeling program for cool pavements at this early stage.

While studies show that pavements can affect surface temperatures, several factors. These include the impact of vegetation and the absorption by buildings and other infrastructure.

There are situations, however, where cooler pavements can be beneficial. Lower surface temperature and higher albedo are beneficial. This is especially true for urban areas with large expanses of paved surface.

Investigations of cool paving materials have shown that pavements with higher solar reflectance benefit from the cooling effect. Properties that increase albedo and minimize absorption are essential in applying either material.

Other factors affecting performance, cost, and the best solutions may occur where multiple solutions help with storm water runoff as well as pavements.
Heat Island Effect

Cool Pavements

- Denotes link to glossary definition

There is no official standard or labeling for pavements.

While studies show that pavements may affect surface temperatures, they do not necessarily cause global warming.

It's NOT a black and white issue.

- pavement thickness
- material capacities
- surface vs. air temperatures
- pavement air voids (OGFC) cooler
- UHI does NOT cause Global Warming

? cooler reflective pavements ?
“Gritting”: reflective chips and aggregate

reflective pavements
Shot-Blasting:
abrades surface binder

reflective pavements
Synthetic and Colored Binders:
using reflective aggregates
Synthetic / Colored Binders:
using reflective / colored aggregates

reflective pavements
recycled pavement

www.PaveGreen.com

ASPHALT

The Nation's #1 Recycled Material

recycled pavement
Common Recycled Materials in Asphalt Pavements

- Shingles
- Crumb / Tire Rubber
- Glass
- Slag
- Foundry sand

All are in different stages of utilization / evaluation
asphalt shingles
milling asphalt pavement
reclaimed asphalt pavement "RAP"
sizing RAP
Reclaimed Asphalt Pavement “RAP”

- Removed and/or reprocessed pavement materials containing asphalt and aggregates
- Over 80 percent of the asphalt pavement, removed each year for widening and resurfacing, is re-used
- Represents close to 100 million tons / year
- RAP is the Nation’s No. 1 recycled material in both total amount and percentage recycled
Percent Recycled

Glass bottles  Paper  Newsprint  Aluminum cans  Scrap Steel  Asphalt Pavmt

FHWA / USEPA Report to Congress, EPA/600/R-93/095.
30,000 Tons of RAP

= 70 - 6,000 Gallon Transport Trailers and 28,200 Tons of Clean Aggregate

**RAP: sustainable & carbon neutral**
The BEES (Building for Environmental and Economic Sustainability) software brings to your fingertips a powerful technique for selecting cost-effective, environmentally-preferable building products. Developed by the NIST (National Institute of Standards and Technology) Building and Fire Research Laboratory the tool is based on consensus standards and designed to be practical, flexible, and transparent. Version 4.0 of the Windows-based decision support software, aimed at designers, builders, and product manufacturers, includes actual environmental and economic performance data for 230 building products.
Environmental Performance

Note: Lower values are better

BEES
Global Warming by Life-Cycle Stage

Note: Lower values are better.
- CO2 emissions generally linked to energy expenditures; less energy → less CO2 emissions
- UHI may be “real” but is only local; NOT a contributor to Global Warming – Sci. American
- Avg. automobile emits ~ 6 tons CO2 annually
- Avg. HMA plant emits ~ 2,500 tons CO2 = 0.0023 Tg
- GHG emissions from HMA production pales in comparison to other industrial sources . . .
Figure ES-6: 2005 CO₂ Emissions from Fossil Fuel Combustion by Sector and Fuel Type

Source: EPA 430-R-07-002 US GHG Emissions

carbon footprint: US sources
Avg HMA plant GHG emissions @ ~ 0.023 Tg
The entire annual CO2 / greenhouse gas emissions / carbon footprint from a typical hot-mix plant (~ 2,500 tons) could be totally offset by using 20 - 25% RAP in pavement mix designs -- accomplished by minimizing acquisition of energy intensive (natural) raw materials such as aggregate and petroleum asphalt.
continually changing technology . .
to drive efficiency = $$ / env comp
This Street Paved With Environmentally Friendly Warm Mix Asphalt

York County South Carolina

Boggs PAVING, INC. GREEN

Warm Mix Asphalt (“WMA”)
Many different technologies
- Waxes, emulsions, and water foaming processes
- Costs differ: some higher, some lower

End-result: to lower mix temperatures from 300 °F → ~ 250 °F (or lower)
- Less energy demand / fuel consumption
- Less emissions: plant and field

Quantifying energy and emissions
- ~ 15% less fuel consumption (min.)
- ~ 15% less CO2 emissions (min.)
- Lower NOx, particulate, other emissions

States, Producers, Contractors, FHWA all interested
- Performance research and many field trials
ASPHALT: 
the environmentally sustainable pavement

- Porous pavements manage stormwater
- OGFCs are safe and quiet
- Reflective / OGFC / Porous can mitigate UHI
  - Remember: UHI doesn’t cause Global Warming
- Asphalt pavements accept recycled goods / are recycled (RAP)
- HMA pavements are environmentally preferred
  - Low energy to construct, low carbon footprint, fast speed of construction
- Warm Mix lowers energy consumption & emissions
- RAP can offset the entire annual HMA GHG emissions
Asphalt is the sustainable material for constructing pavements.

From the production of the paving material, to the placement of the pavement on the road, to rehabilitation, through recycling, asphalt pavements minimize impact on the environment. Low consumption of energy for production and construction.