

Green Highways:

American Concrete Paving Industry's Perspective

9th Annual Pennsylvania Concrete Conference



January 30, 2008
Grantville, Pennsylvania

Count on Concrete

Lets get one thing straight!

- So-called *"global warming"* is just a secret ploy by wacko tree-huggers to make America energy independent, clean our air and water, improve the fuel efficiency of our vehicles, kick-start 21st-century industries, and make our cities safer and more livable. Don't let them get away with it!

- Chip Giller



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What are Green Highways?

- Environmentally and Economically Sustainable Concrete Pavements!**
- What is sustainability?
"Meet[ing] the needs of the present without compromising the ability of future generations to meet their own needs"
[UN General Assembly 1987]



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Green Highways Initiative

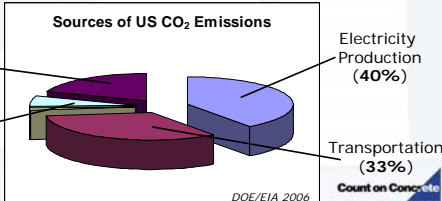
- In 2005, EPA started the Green Highways Initiative as an instrument for coordinating environmentalism and transportation
- Focus on demonstrating and ensuring that sustainable practices and economic success can go hand-in-hand!
- This is indeed true of concrete pavements!**




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What about Cement?

- Although cement is a relatively energy and CO₂ intensive material to manufacture... cement manufacturing accounts for only 1.5% of US CO₂ emissions – the balance comes from...




Sources of US CO₂ Emissions
DOE/EIA 2006

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What about Cement?

- Includes CO₂ emissions of cement manufacture for all concrete and masonry uses (not just pavement)...
- Concrete most widely used material on earth, apart from water (www.wbcasd.org)
- Cement industry has lowered the amount of energy required to make a ton of cement by 33% since 1972
- CMS program pledge another 10% by 2020



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What about Concrete?

- 92% of paving concrete is comprised of materials that have a low CO₂ footprint...
- All these materials are available/manufactured here in the US, often locally
- Overall sustainability benefits associated with use of concrete for pavements dramatically outweigh the impact of the cement manufacturing process...

SCM 3%
AIR 6%
CEMENT 8%
WATER 16%
SAND 26%
ROCK 41%

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Concrete Pavements!

- Longevity** - hallmark of concrete pavements
- I-10 east of Los Angeles: Originally constructed in 1946 as part of US Route 66
 - Ground in 1965 (1st continuous grinding project in north America) to correct joint spalling and faulting
 - Reground for 3rd lease on life in 1984
 - In 1997 the 51 yr old PCCP was ground again
 - Today the concrete is carrying 240,000 vpd...

A true testament to concrete pavement sustainability!

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Concrete Pavements!

- Not just isolated example in California...
- 50 year old pavements common in US...
- Route 23 Minnesota
 - Built 1948 (Ogilvie)
 - JPCP, 9", doweled
 - PSR 4.1 (very good)
 - > 50%, >50yr are >3.1
- TX, NY, IA, SC, WA...

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Longevity means...

- Less-frequent reconstruction
- Lower consumption of raw materials
 - Cement, aggregates, steel
- Lower energy consumption
 - Raw material processing
 - Rehab and reconstruction
 - Congestion

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Longevity means... (cont.)

- Reduction in pollutants
 - Manufacturing, construction, congestion
- Lives saved
 - Rigid structure, profile durability
 - Infrequent construction zones
- All these translate into real economic benefits...

Longevity is a crucial element of sustainability!


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Green Benefits *Beyond* Longevity

- Improved Fuel Economy
- Lower Energy Footprint
- Light Colored and Cool
- Less Fuel Consumed During Construction
- Industrial By-Product Use
- Renewal and Recycling
- Improved Stormwater Quality
- New Quiet Surface Textures

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Improved Fuel Economy



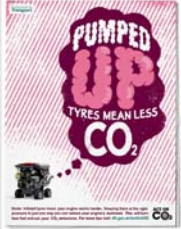
- Rigid surface → less deflection → less loss
- In-depth study by NRC Canada and NRCan
- Significant fuel consumption reductions for trucks on concrete pavement (0.8-6.9%)
- Average savings **per truck** (100,000mi, 5.5mi/G, \$3.19/G)
 - \$2,233 – 8.1tn CO₂ – 183lb NO_x – 22lb SO₂
- Huge environmental and cost savings...

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Improved Fuel Economy: Example

62 mile long arterial highway; 20,000 vpd; 15% trucks; 5.5mpg; 30yr design life...

- An average of **165,000 tons CO₂** saved
- Greater than **three times** as much CO₂ as emitted during cement manufacture!
- CO₂ associated with concrete pavement is compensated for during the **first 9 years**



Count on Concrete

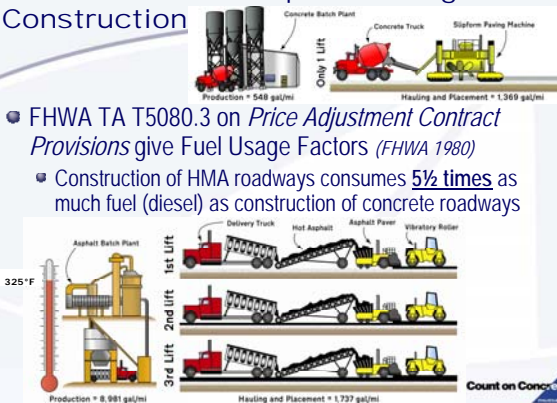
Improved Fuel Economy

- Series of publications to illustrate this point...



Count on Concrete

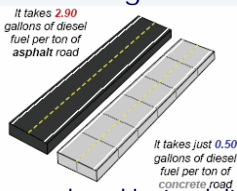
Lower Fuel Consumption during Construction



- FHWA TA T5080.3 on *Price Adjustment Contract Provisions* give Fuel Usage Factors (FHWA 1980)
 - Construction of HMA roadways consumes **5½ times** as much fuel (diesel) as construction of concrete roadways

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Lower Fuel Consumption during Construction



- FHWA estimates that 500 million tons of HMA placed annually
- If concrete roadways were placed instead, it would amount to an annual fuel savings of **1.2 billion gallons** [1.45BG – 0.25BG]
- Savings are staggering - CO₂ equivalent to taking 2.7 million cars off the road!

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Use of Industrial By-Products

- Concrete is a huge consumer of industrial by products (SCM's primarily)
- Up to 25% FA, 50% SC, ternary blends
- Reduces disposal, lowers cement intensity (with its CO₂) and improves both performance and longevity!
- Slag aggregates.



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Renew-ability, Recycling and Reuse


- Grinding – CalTrans expect 17 years additional life from pavement grinding jobs
- Concrete 100% recyclable – in new concrete, subbases and granular fill (even on-site operations)
- Carbon sequestering through carbonation:
 - 60% of the CO₂ emitted during cement production is due to calcination, which can be recaptured at the end of its life (RMRC '05)
 - 53 million tires used in cement kilns (EPA '03)




Light Colored and Cool

Enhanced Nighttime Visibility:

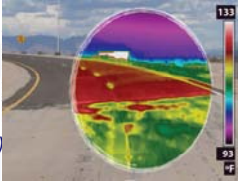

- Improved pedestrian and vehicular safety
- Reduced lighting and energy requirement:
 - Fewer fixtures or lower wattage fixtures
 - Up to 1/3 energy savings!

Light Colored and Cool

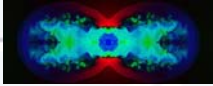

Urban Heat Island Mitigation:

- Urban areas up to 9°F warmer due to UHI → greater energy use and resulting pollution
- PCCP is an effective mitigation strategy
 - lower city temperatures
 - lower cooling costs
 - reduce smog formation
- Pot. energy savings \$5B in US alone (LBL '05)

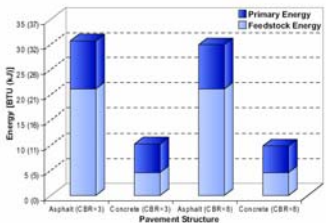
Lower Energy Footprint

- Embodied primary energy is a measure of all energy use associated with the production, delivery and maintenance of a facility over a specific period
- Includes both feedstock and primary energies
- ASMI analyzed total embodied primary energy for various equivalent concrete & asphalt pavement structures for several different road types in various geographic regions over a period of 50 years (Athena '06)





Lower Energy Footprint

- Considers:
 - Extracting
 - Processing
 - Production
 - Construction
 - Maintenance
 - Rehabilitation
- Concrete lower for all classes analyzed!
 - 23% lower for urban freeways
 - 71% lower if feedstock energy is considered!





Pavement Structure	Primary Energy (BTU/ft ²)	Feedstock Energy (BTU/ft ²)
Asphalt (CBR=3)	~28	~15
Concrete (CBR=3)	~12	~5
Asphalt (CBR=8)	~32	~18
Concrete (CBR=8)	~15	~5



Improved Water Quality

Use of Pervious Concrete Pavements:

- Reduce storm water runoff
- Capture/treat pollutants
- Recharge groundwater
- Evaporative cooling
- Reduce noise pollution

New Quiet Surface Textures

- Create any desired surface texture...
- FHWA TA 5040.36 on Surface Texture (FHWA '05)
- Research by FHWA, NCPTC, ACPA, Purdue, etc.
 - Optimize friction/vehicle control
 - Minimize noise pollution
- NGCS – quietest PCCP texture measured (2007)
- Surface texture/profile durability!



Summary



Concrete's many green benefits make it *the* sustainable choice.

(Courtesy NRMCA)

In Conclusion...

- North American concrete paving industry strongly supports sustainable development
- Concrete pavements are the clear choice for environmentally sensitive and economically sustainable roadways – key is **LONGEVITY!**

- truly Green Highways in more ways than one!



Resources...

ACPA Education & Training
Making the world's best pavements even better!

- ACPA published a Special Report on Green Highways
- Printed in October 2007
- Available on our website at: www.pavement.com



Topics for our 2008 program :

- Concrete Mix Design Basics
- Concrete Pavement Materials
- PCCP Sustainability
- Curing
- Hydration Processes
- Introduction to the M-E PDG
- Joint Layout and Design
- Life Cycle Cost Basics
- Materials Incompatibility
- Maturity
- Slipform Paving Operations
- Soil Stabilization
- Texturing Concrete Pavements
- Thickness Design – Municipal
- Troubleshooting Slabs on Grade

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Questions?

