ASPHALT
Why North America Rides on Us

94% of pavements are asphalt

June 2013 NHL News
In an abbreviated season the Leafs dazzle...
AND

WIN THE CUP
ASPHALT PAVEMENT

- Has been the dominant pavement type
- Continues to be the dominant pavement type

WHY?

Because ...

It’s CHEAP

Because ...

Good Value
Safe
Sustainable

SUSTAINABLE

What’s this all about?
1970 Ford Galaxie

2012 Ford Taurus

Emissions Per Light Vehicle

- 1970: 8.12 tons
- 2005: 5.35 tons
- 34% decrease
The streets of Vancouver are paved with ... recycled plastic

By Paul Ridden
November 30, 2012
Article Summary
According to the Economist Intelligence Unit's latest Global Liveability Report, the beautiful city of Vancouver in Canada is a pretty decent place to live, ranking third in the world. Its environmental footprint is currently unsustainable, though, prompting officials to hatch an ambitious plan to have Vancouver crowned the greenest city in the world by 2020. Helping things along nicely is a new warm mix paving process that makes use of the kind of waste plastic placed in blue household recycling boxes by conscientious citizens, reducing greenhouse gases and improving air quality along the way.

FHWA Pavement Sustainability Technical Working Group

- Meet Semi–Annually
- Identify Research Needs
- Provide Technical Guidance

FHWA Expert Task Group on Sustainability

- Pavements
- Paving Materials
- Pavement Maintenance
- User Operations

What’s Behind It?

- How to Evaluate Environmental Effects of Pavement Systems

Life Cycle Cost Analysis

Life Cycle Analysis
Life Cycle Cost Analysis

- an engineering economic analysis of alternative investment options.

Life Cycle Assessment

- assess the environmental impacts from all stages of life from cradle to grave – to cradle again.

Life-Cycle Cost Analysis

- Materials
- Construction
- Use
- Mtce
- Rehab
- End-of-Life

Boundaries

- Where to Set
- Grades
- Stopping
- Alternate Transportation
**Estimate of US Emissions for Hot-Mix Asphalt Production**

- **U.S.A.**
  - In 2011, 380 million tons of asphalt mix
- **Typical Production Parameters**
  - No. 2 Oil, 4% Stockpile Moisture
  - 165°C Mix Temperature (110°F Stack)
- **Estimated Annual** **HMA Emissions**
  - ~ 8,222,000 US tons CO₂e

**Percentage of Total Asphalt Production in US**

-source: National Asphalt Pavement Association
As move continues to from Hot-Mix
Equivalent to removing 1.5 million cars off the road

25% Savings

Total Predicted WMA Annual Emissions ~ 6,087,000 US tons CO₂e at 130°C

Use Phase

Initial Construction

pavement carbon footprint

use phase carbon
Vehicle fuel use

<table>
<thead>
<tr>
<th>Time</th>
<th>CO2 per lane mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>200</td>
<td>100</td>
</tr>
</tbody>
</table>

Maintenance

<table>
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<th>Time</th>
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4 Million Total Miles
600,000 Bridges

NHS 160,000 miles
- 4% of roads
- 40% VMT
- 75% Heavy Truck VMT
- 90% Tourist Traffic

IRI / MPD MIRIAM RRC Model

\[ RCC = C_1 + C_2 \cdot MPD + C_3 \cdot IRI + C_4 \cdot IRI \cdot (V - V_{ref}) \]

MIRIAM Model Rolling Resistance
Example Concrete Section 30 year Period
Smoothness

WesTrack Fuel Consumption

"Pavement roughness had a significant impact on fuel consumption of trucks applying loads to WesTrack pavement test sections. Under otherwise identical conditions, trucks used 4.5% less fuel on smooth (post rehabilitation) than on rough (pre rehabilitation) pavement."

- NCHRP Report 455

### 2009 NHS

- 40% of All Traffic
- 75% of All Freight Traffic

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mileage of NHS (%)</th>
<th>Km Traveled (%)</th>
<th>CO₂e(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor IRI &gt; 2.69 m/km</td>
<td>8%</td>
<td>11%</td>
<td>8% additional</td>
</tr>
<tr>
<td>Fair</td>
<td>66%</td>
<td>69%</td>
<td>Net 0%</td>
</tr>
<tr>
<td>Good IRI ≤ 1.50 m/km</td>
<td>26%</td>
<td>20%</td>
<td>3% savings</td>
</tr>
</tbody>
</table>

### Project Level (LCA)

LC Phases & System Boundaries

1. Material Production
2. Construction, Maintenance, & Rehabilitation
3. Use...
4. End-of-Life...
URBAN HEAT ISLAND

- Role of pavements
- Asphalt pavement
- Concrete pavement

FIWA Study
Quantifying Pavement Albedo

Basic Albedo Model

Average Daily Solar Radiation Per Month
Measuring solar reflectance with an albedometer

Basic Thermal Model

30 FEET = CONSTANT THERMAL PROPERTIES (TEMP)

PAVEMENT
AGGREGATE BASE
SUBGRADE - 1
SUBGRADE - 2
SUBGRADE - 3

NOTE: this is relevant to the lower boundary condition as heat conduction.

Mid Central City
(Test protocol & measurement verification)
Light aggregate geology
5 asphalt, 5 concrete
2 (0-5), 1 (5-10), 2 (10-15) pavement surface age (yrs)

SW City
Dark aggregate geology
5 asphalt, 5 concrete
2 (0-5), 1 (5-10), 2 (10-15) pavement surface age (yrs)

NC City
Light aggregate geology
5 asphalt, 5 concrete
2 (0-5), 1 (5-10), 2 (10-15) pavement surface age (yrs)

NE City
Dark aggregate geology
5 asphalt, 5 concrete
2 (0-5), 1 (5-10), 2 (10-15) pavement surface age (yrs)

SC City
Light aggregate geology
5 asphalt, 5 concrete
2 (0-5), 1 (5-10), 2 (10-15) pavement surface age (yrs)

SE City
Light aggregate geology
5 asphalt, 5 concrete
2 (0-5), 1 (5-10), 2 (10-15) pavement surface age (yrs)
**IARC Monograph103**

**Heritage Research Group**

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**Bitumen Industry Efforts**

- Last review of bitumen by IARC in 1987
- Working to understand long term health effects globally
- Many of the published (peer reviewed studies) were sponsored by industry

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**Definition of Bitumen Emissions (Emissions)**

When you heat bitumen especially in thin films, volatile compounds can be released
Why study bitumen and bitumen emissions?

- Unknown long term health effects on workers!

Route and Exposure Levels

- Inhalation
- Dermal
- Ingestion

IARC Monograph Review

1. is carcinogenic to humans
2A. is probably carcinogenic to humans
2B. is possibly carcinogenic to humans
3. is not classifiable as to carcinogenicity in humans
4. is probably not carcinogenic

Other 2B Classifications

- Gasoline Engine Exhaust
- Firefighter
- Coffee
- Cell Phones
Implications

- Continue efforts to reduce exposure
- Warm Mix Technologies (lower temperature)
- Replace diesel oil for cleaning with biodiesel
- Wear gloves
- Consider engineering controls

Continuing to improve asphalt’s environmental sustainability

- RAP
- Shingles
- Porous
- Smooth
- Perpetual

Asphalt Pavement
Green As The Wind

Thanks