The Eco-Efficiency of Cape Seals

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Concord, California

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BASF Corporation
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Sustainability Evaluation

- Information to better understand your value chain
- Provides a forum to actively engage your customers
- Helps grow your business
BASF has a robust, science based tool box for helping us evaluate the relative sustainability of products and processes over their life cycle.

- Clearly and easily depicts the environmental, social, and economic values and trade-offs between different products.
- Over 600 studies completed globally for diverse products and market applications.
- Following Industry Standards. Methodologies 3rd party validated by TÜV, DNV and NSF. Externally communicated studies verified by NSF in North America.
Ecology (Environment)

- Emissions to Air & Water
- Greenhouse gases
- Waste
- Resource efficiency
- Renewables

- Water
- Human Toxicity
- Land use
- Energy

Holistic Environmental Assessment
Economics

Traditional Cost Categories
- Maintenance & Repair
- Labor
- Logistics
- Capital Investment
- Material Costs
- Energy
- Utilities

Non-traditional Cost Categories
- Process Efficiency
- Training
- Durability
- Disposal
- Lost Revenue

Total Cost of Ownership
Evaluating the full life cycle

Production (cradle to gate)

Basic Raw Materials (cradle)

Product Use

Recycle / Return

Disposal (cradle to grave)
Compare alternatives
Environmental Fingerprint

- Land Use
- Fossil Resources
- Mineral Resources
- Water
- Eutrophication
- Acid Rain
- Ozone Depletion
- Climate Change
- Summer Smog
- Toxicity

Better
Worse

Alternative 1
Alternative 2
Alternative 3

WRAPP
Western Regional Association for Pavement Preservation
Dedicated to the improvement and promotion of the industry
Stakeholder input

How does society and stakeholders feel about environmental impacts

Talk with stakeholders and conduct interviews

North American Weighting Factors

<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Weighting Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Change</td>
<td>12%</td>
</tr>
<tr>
<td>Ozone Depletion</td>
<td>9%</td>
</tr>
<tr>
<td>Human Toxicity</td>
<td>17%</td>
</tr>
<tr>
<td>Eutrophication</td>
<td>13%</td>
</tr>
<tr>
<td>Summer Smog</td>
<td>8%</td>
</tr>
<tr>
<td>Resources</td>
<td>11%</td>
</tr>
<tr>
<td>Land use</td>
<td>7%</td>
</tr>
<tr>
<td>Water Consumption</td>
<td>13%</td>
</tr>
<tr>
<td>Acidification</td>
<td>10%</td>
</tr>
</tbody>
</table>
Compare alternatives Eco-efficiency
Information to support your business strategy

- **Product Development**
- **Understand Competitive Advantages & trade-offs**
- **Align Solution with Customer Need**
- **Sustainability communications**
- **Advocacy**
- **Eco-certifications**
- **Drive Sales & Increase Added Value**
The Eco-efficiency of Cape Seals
## Customer Benefit and Alternatives

<table>
<thead>
<tr>
<th>Customer Benefit</th>
<th>Hot Mix Alternative</th>
<th>Cape Seal Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventive maintenance of a 1 mile stretch of a 12 foot lane of a rural road to a similar profile and performance using best engineering practices over a 40 year period.</td>
<td>Hot mix asphalt (HMA) 1.5” thin overlay. Warm mix alternatives also RAP additions were included.</td>
<td>Hot applied chip seal (AR/GTR modified in two geographical areas) followed by a micro-surfacing application.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Modified emulsion chip seal in two geographical areas, followed by a micro-surfacing application.</td>
</tr>
</tbody>
</table>
System diagram for generic life cycle of Cape Seal I (AR chip seal + micro surfacing) - California (West Coast)

Grey boxes are not considered, since they are the same for all alternatives.
System diagram for generic life cycle of Cape Seal II (polymer modified emulsion chip seal + micro surfacing)

Grey boxes are not considered, since they are the same for all alternatives.
System diagram for generic life cycle of Cape Seal I (GTR Chip Seal + Micro surfacing) – Southeast

Grey boxes are not considered, since they are the same for all alternatives.
Grey boxes are not considered, since they are the same for all alternatives.
Project Alternatives for Cape Seal Eco-efficiency Analysis

- **California (West Coast):**
  - Cape Seal Technology I (asphalt rubber (AR) chip seal + micro surfacing)
  - Cape Seal Technology II (SBR polymer modified emulsion chip seal + micro surfacing)
  - Hot Mix Asphalt (HMA) – (1.5” thin hot mix overlay)

- **Southeast:**
  - Cape Seal Technology I (ground tire rubber (GTR) chip seal + micro surfacing)
  - Cape Seal Technology II (SBR polymer modified emulsion chip seal + micro surfacing)
  - Hot Mix Asphalt (HMA) – (1.5” thin hot mix overlay)

Additional scenarios were added which include increased durability of hot mix overlay, warm mix (energy savings), and warm mix (energy savings and additional RAP)
# General Product Formulation & Composition – Cape Seal Technologies

<table>
<thead>
<tr>
<th>Binder Composition</th>
<th>Asphalt Rubber Chip Seal (West coast)</th>
<th>SBR Modified Chip Seal</th>
<th>GTR Chip Seal (Midwest / Southeast)</th>
<th>Micro surfacing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PG 64 16</td>
<td>CRS-2P</td>
<td>AC-20-5TR</td>
<td></td>
</tr>
<tr>
<td>Crumb Rubber</td>
<td>20.0%</td>
<td></td>
<td>15.0%</td>
<td>61.0%</td>
</tr>
<tr>
<td>Bitumen (asphalt cement)</td>
<td>77.5%</td>
<td>67.6%</td>
<td>83.0%</td>
<td></td>
</tr>
<tr>
<td>Extender/Rejuvenating Oil</td>
<td>2.4%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Natural Crumb rubber</td>
<td>0.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polymer</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBR</td>
<td>%</td>
<td>3.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBS</td>
<td>%</td>
<td></td>
<td></td>
<td>3.50%</td>
</tr>
<tr>
<td>Emulsifier</td>
<td>%</td>
<td>0.2%</td>
<td></td>
<td>1.50%</td>
</tr>
<tr>
<td>HCL (20 BAUME)</td>
<td>%</td>
<td>0.2%</td>
<td></td>
<td>1.00%</td>
</tr>
<tr>
<td>Water</td>
<td>%</td>
<td>28.7%</td>
<td></td>
<td>33.00%</td>
</tr>
<tr>
<td>TOTAL %</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

### Tack Coat Composition

<table>
<thead>
<tr>
<th>Component</th>
<th>SS-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen wgt %</td>
<td>63.00%</td>
</tr>
<tr>
<td>Water wgt %</td>
<td>34.00%</td>
</tr>
<tr>
<td>Emulsifier wgt %</td>
<td>2.50%</td>
</tr>
<tr>
<td>Saponifier wgt %</td>
<td>0.50%</td>
</tr>
<tr>
<td>TOTAL wgt %</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
The hot mix overlay (mill & fill) was a 1.5” application (which includes compaction) was assumed. Allowable maximum RAP amounts were 15% for the west coast model and 20% for the southeast model.

### Application rates - Cape Seal alternatives

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Chip Seal (West Coast)</th>
<th>Chip Seal SBR Polymer Modified</th>
<th>Chip Seal Southeast AC-20-5TR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chipseal binder gal/sq. yd</td>
<td>0.65</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>Aggregate sq. yd./cu. Yd.</td>
<td>120.0</td>
<td>125.0</td>
</tr>
<tr>
<td>Microsurfacing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Top layer application</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lbm/yd2</td>
<td>10.0</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>kg/yd2</td>
<td>10.0</td>
<td>22</td>
</tr>
</tbody>
</table>
For the California (West Coast) analysis, both cape seal technologies had lower GWP than the hot mix asphalt (HMA) overlay. Between the cape seal technologies, the asphalt rubber based cape seal had a GWP about 10% less than the polymer modified emulsion based cape seal.
Asphalt rubber cape seal scores highest in all categories, followed by asphalt emulsion cape seal.
Bar graph comparisons show hot mix has the highest overall environmental impact.
In the southeast analysis, the emulsion cape seal scored the lowest followed by the GTR cape seal.
Bar graph comparisons show that the hot mix alternative has a higher overall environmental impact.
A life cycle cost analysis shows the AR Cape Seal has the lowest cost in the life cycle analysis.
### Overall Economic Results – Southeast

The life cycle analysis shows that the cape seals are about 25% less expensive than the hot mix alternative.

<table>
<thead>
<tr>
<th>Unit Costs</th>
<th>Unit</th>
<th>Cape Seal I (GTR Chip)</th>
<th>Cape Seal II</th>
<th>HMA Overlay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material / Pavement</td>
<td>$/yd²</td>
<td>$4.50</td>
<td>$4.35</td>
<td>$6.60</td>
</tr>
<tr>
<td>Milling</td>
<td>$/inch</td>
<td></td>
<td></td>
<td>$3.00</td>
</tr>
<tr>
<td>Striping</td>
<td>$/ft</td>
<td>$0.23</td>
<td>$0.23</td>
<td>$0.23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Life Cycle Costs</th>
<th>Unit</th>
<th>Cape Seal I (GTR Chip)</th>
<th>Cape Seal II</th>
<th>HMA Overlay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material / Pavement</td>
<td>$/CB</td>
<td>$106,867</td>
<td>$103,304</td>
<td>$159,275</td>
</tr>
<tr>
<td>Striping</td>
<td>$/CB</td>
<td>$16,386</td>
<td>$16,386</td>
<td>$12,646</td>
</tr>
<tr>
<td>Disposal</td>
<td>$/CB</td>
<td>$432</td>
<td>$460</td>
<td>$447</td>
</tr>
<tr>
<td>Lane Rental Fee</td>
<td>$/CB</td>
<td>$22,326</td>
<td>$22,326</td>
<td>$17,287</td>
</tr>
<tr>
<td>Sum</td>
<td>$/CB</td>
<td>$146,011</td>
<td>$142,477</td>
<td>$189,656</td>
</tr>
</tbody>
</table>
Eco-efficiency portfolio base case analysis – California (West Coast)

For the west coast study the AR cape seal was the most eco-efficient application, followed by the emulsion cape seal.
Eco-efficiency base case analysis – Southeast

In the southeast study, the emulsion cape seal was the most eco-efficient alternative.
The data from a NCHRP research report shows that a mix temperature decrease of 30°F to 115°F generally resulted in a fuel savings of between 10-50%.
Eco-efficiency Portfolio
California (West Coast): HMA lower production temperatures (Energy Savings: 10% - 50%)

Even at a 50% energy savings, the hot mix overlay still lags the eco-efficiency of both cape seal applications.
Eco-efficiency Portfolio
Southeast: HMA lower production temperatures (Energy Savings: 10% - 50%)

The energy savings in warm mix applications will allow the HMA to overtake the GTR Cape seal, but still lags the modified emulsion cape seal.
Eco-efficiency Reports

Chip Seal Eco-Efficiency Report

Microsurfacing vs. Hot Mix Overlay Eco-Efficiency Report
For More Information:

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