ReGen-erating Aged Binder

Virginia Pavement Research & Innovation Symposium
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Recent Decline in Pavement Quality Associated with RAP/RAS

Recycling Responsibility. Asphalt Institute, 9/17

During the last decade, the quality/life of asphalt pavements in U.S. have **DECREASED**.

One state reported a **DECREASE** in pavement life of about **4 YEARS**

Opinion: Issues with cracking stem from **improper use of RAP/RAS**
Memorandum

Subject: **ACTION**: Recycled Materials in Asphalt Pavements

Date: October 20, 2014

Recently there have been an increasing number of state highway agencies reporting pre-mature cracking in relatively new asphalt pavements. A similarity in many of these pavements is the high content of recycled asphalt binder.

Cracking due to low temperatures or thin pavement sections. Additionally, there is concern for potential increased asphalt aging during the pavement performance life, in particular with RAS that contains already higher aged asphalt binder. There is also an inability to accurately predict an asphalt mixture’s cracking potential with existing laboratory test procedures that are not always related to actual pavement condition and might provide conflicting recommendations.
Asphalt Concrete Pavement Performance

2.25 million miles of asphalt-paved roads in the U.S. alone.

- Average rating is D-
- 1/5 miles in Poor condition
- Annual backlog $80B
Pavements Can Perform

5(?) years old

14 years old

Huber, AMAP 2019
Starting with Aged (RAP) Binder (20% avg)

QIP-129 (NAPA 2015)

Multi-source RAP pile (RAP Best Practices. NCAT 2010.)
Re-using Aged Asphalt

New Pavement + Aged Pavement ≠ New Pavement

New Mixture + Aged Mixture = New Mixture?

Assumed!
### Different approach to RAP:

<table>
<thead>
<tr>
<th>Country</th>
<th>Binder quality</th>
<th>Binder upgrade</th>
<th>Method</th>
<th>Winning Bid</th>
<th>Warranty</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Japan</strong></td>
<td>Waste/Very Poor</td>
<td>Mandatory (&quot;rejuvenation&quot;)</td>
<td>Mandatory E/R/Testing</td>
<td>Lowest Life-cycle Cost</td>
<td>Mandatory/Long-term</td>
</tr>
<tr>
<td><strong>US</strong></td>
<td>Good enough to replace virgin binder</td>
<td>None required/ &quot;soften&quot; virgin binder</td>
<td>No RAP binder testing required</td>
<td>Lowest Initial cost</td>
<td>Rare/Short (&lt;2 yrs)/None</td>
</tr>
</tbody>
</table>

### Present Day:

<table>
<thead>
<tr>
<th>Country</th>
<th>Average RAP (%)</th>
<th>Roads in Good condition (%)</th>
</tr>
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<tbody>
<tr>
<td><strong>Japan</strong></td>
<td>47%</td>
<td>97%</td>
</tr>
<tr>
<td><strong>US</strong></td>
<td>20%</td>
<td>30%</td>
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</table>

- **Japan:** 97% roads in Good condition
- **US:** 30% roads in Good condition

- **Japan:** $80 billion annual backlog
- **US:** $20 billion annual backlog

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Europe Delivers Longevity under Extreme Traffic Conditions

European engineers have certainly had no problem handling the heavy traffic issue as pointed out in this 2016 article: *Why are America’s Roads so much worse than Europe’s?*

The article states that **European autobahns** carry “more traffic” and “considerably heavier truck weights” yet are “smoother” and “far sturdier” than American highways. European highways are designed and constructed to last 40 years. It isn’t an issue of traffic intensity but an issue of targeting longevity, including materials and specifications capable of delivering it.

"American contracting procedures discourage the use of novel techniques. In Europe, governments dictate only how long a highway should last under what conditions, and contractors are left to their own devices to deal with the challenge. In the U.S., contractors must meet an avalanche of government specifications on materials and procedures but are not required to guarantee the road’s performance. The Europeans create a contract climate that stimulates innovation; here we squash it," laments Douglas Bernard, director of the Office of Technology Applications in the Federal Highway Administration."
Aged Asphalt Binder (from RAP)

Currently approved in most states to replace up to 20% of required binder in mix.
Aged Asphalt Binder (from RAS)

Currently approved in many states to replace up to 20% of required binder in mix.
Better Handling/Constructability

Design % Air Voids ($N_{DES}=100$)

- 20% RAP Control Mix
- 40% RAP + 3% RAS + soft binder Mix
- 40% RAP + 3% RAS ReGen Mix
- ReGen

TARGET
Asphalt Pavement Principles: Long-Life Pavements

**MATERIALS**

- **High Quality AC**
  - Typically 1.5-3”

- **High Modulus, Rut Resistant AC**
  - Typically 4-7”

- **Fatigue Resistant AC**
  - Typically 3-4”

- **Strong Pavement Foundation**

Scroll for details
Superior Mix Fatigue Resistance (Fatigue-Resistant Bottom AC Layer)
<table>
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<tr>
<th>MATERIALS</th>
<th>TYPICALLY</th>
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Sustained Age-Resistance

“Bottom-grade” with aging time

PG 67 “-22”

36
66
80

41
52

17

3

20

71
82

49

30

55

67

PAV Hours to Drop in Continuous PG\textsubscript{LOW}

PAV hrs to -22°C

PAV hrs to -16°C

PAV hrs to -13°C

Avg. Virgin PG 67-22

30% RAP + PG 67-22

60% RAP + PG 52-58

30% RAP + PG 67-22 + ReGen

60% RAP + PG 52-28 + ReGen

30% RAP + ReGen® > PG 67-22

60% RAP + ReGen® > 30% RAP
ReGen Plant Mix Performance

• **Volumetrics**
  - Asphalt %, RBR (AASHTO M323, FM 5-563)
  - Bulk, Max SG ($G_{mb}$; $G_{mm}$), (FM 1-T 166; FM 1-T 209)
  - AV (%), AASHTO T 289

• **Mix Performance**
  - Rutting (Hamburg @ 50C, AASHTO T324)
  - Cracking (Illinois Flexibility Test, I-FIT @ 25C)
  - Durability (R30 LTOA + Cantabro Mass loss %, AASHTO TP 108)

• **Conclusions**
  - 45% and 60% RAP + ReGen® mixtures:
    - ✓ met all volumetric requirements
    - ✓ matched mix performance of control
    - ✓ Lower mix cost than control

        ![Graph](graph.png)

        **HWTD Test - Avg. Deformation**
        - 45% RAP + ReGen®: 3.29
        - 45% RAP + ReGen®: 4.03
        - 45% RAP + ReGen®: 3.61

Customer impressed by “wet” appearance compared to RAP control mixture.
High % RAP + ReGen®

Constructability
Thank You from Blacklidge!

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