Effects of Recycled Materials in Asphalt Field and Lab Operations

By
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Hot Mix Asphalt (HMA) utilizing recycle materials is the predominant form of mix production in the Industry.
According to Asphalt Pavement.ORG

• “According to the most recent survey, more than 79 million tons of recycled materials — primarily reclaimed asphalt pavement material (RAP) and recycled asphalt roofing shingles (RAS) — were used in new asphalt pavement mixtures during the 2016 construction season.”
Recycle Materials - Recycled Asphalt Shingles
OTHER RECYCLE MATERIALS

• Ground tire rubber (multiple processes used)
• Processed Ground Glass
• Crushed Tiles (and similar composite materials)
• Plastics (in binders)
Effects of Recycled Materials in Asphalt Field and Lab Operations

- **Considerations in Using Recycle Materials**
  - Specifications limits
  - Type of Recycle Material
    - RAP
    - RAS
  - Availability of recycle material
  - Mixture design issues
  - Plant capabilities/issues
  - Laydown operations
Utilization of Recycle Materials

• Considerations in Using Recycle Materials
  • Specifications limits
    • EXAMPLE

EX: SP125C w/PG 64-22
-<30 % Effective binder replacement, No additional binder testing
->30 % Effective binder replacement, Will need AASHTO M323, APPENDIX X1,X2 blend data
Utilization of Recycle Materials

- Considerations in Using Recycle Materials
  - Specifications limits
    - EXAMPLE

EX: BP-2 w/PG 64-22

- BP2 w/40 % RAP, RAP %ac=5.0,
% Recycle Binder (in mix)=2.0%
%Effective Binder=4.9 %,
% Effective Binder Replacement=40.8 %
TESTING NEEDED: Binder Blend Chart
Ammann Plant, Columbus, OH

2019 AVERAGE RAP%=55%

60% RAP in 9.5mm Surface

70% RAP in 19.0mm Base
Effects of Recycled Materials in Asphalt Field and Lab Operations

• Considerations in Using Recycle Materials
  • Type of Recycle Material
    • RAP
    • RAS
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Crushing/Screening of RAP is an integral part of making a consistent HMA product.
Effects of Recycled Materials in Asphalt Field and Lab Operations

• **Considerations in Using Recycle Materials**
  • RAP:
    • If using lower % RAP (<15 %) may get by with a one grading (ex. 1/2” minus RAP)
    • If using higher % RAP, fractionated RAP will help in maintaining consistency
      • COARSE RAP, FINE RAP
Effects of Recycled Materials in Asphalt Field and Lab Operations

- Testing of recycle products needed to maintain consistent mixture properties:
Effects of Recycled Materials in Asphalt Field and Lab Operations

• Considerations in Using Recycle Materials
  • Recycled Asphalt Shingles
    • Processing the shingles required
Effects of Recycled Materials in Asphalt Field and Lab Operations

• **Considerations in Using Recycle Materials**
  • Recycled Asphalt Shingles
    • If feeding RAS as sole recycle material consider preblending with a sand
      • Erratic feed for low feed rate (2.5-4.0% cold feed)
      • 50/50 blend with sand (mfg. sand/nat. sand) would increase ≥5% for better feed
    • If feeding both RAP and RAS can preblend RAP/RAS for more consistent feed
Effects of Recycled Materials in Asphalt Field and Lab Operations

• Considerations in Using Recycle Materials
  • Availability of recycle material
    • Rural areas may have greater challenge for excess of RAP:
      • may choose lower % feed rate to spread RAP over more mix tons
      • May choose to blend RAP and RAS to maximize recycle asphalt content
    • Less factors to deal with
Effects of Recycled Materials in Asphalt Field and Lab Operations

• Considerations in Using Recycle Materials
  • Availability of recycle material
    • Urban areas may have large surplus of recycle (RAP)
      • May choose high % RAP
      • May have to use softer binder grade or rejuvenator for blending to address:
        • Meeting specification requirements
        • Minimizing mixture cracking susceptibility
        • Workability for laydown crews
Effects of Recycled Materials in Asphalt Field and Lab Operations

- Mix Design Issues:
  - RECYCLE ASPHALT CONTENTS UTILIZED
    - Strong thought that RAP may only offer up 80-85% of the TOTAL RAP % Binder and RAS only 50%
    - If taking 100% credit for the TOTAL Binder content Mix may be actually be realizing a lower % asphalt content that is truly effective-MIX DRY
    - If HMA w/Recycle has the asphalt extracted, recovered and graded is that truly correct?
    - Most State agencies require extracted, recovered binder grading for confidence check on blended binder properties
    - Performance Testing (CRACK and RUT testing better solution)
Effects of Recycled Materials in Asphalt Field and Lab Operations

• If recycle % requires a modifier to address binder stiffness:
  • Can use a softer binder grade (ex. PG 58-28 instead of the Contract bid item PG 64-22
  • Can use a rejuvenator with PG 64-22 to address moderate/moderately high RAP %’s (30-40%)
  • If RAP % are very high (45 %+), a softer binder grade and a rejuvenator may be needed
  • RAS: Have seen 176 to 185 C High temperature grades and low temperature grading to +25 C. What do you blend?
ADDITIVE (REJUVENATOR) SUPPLY SYSTEM

INDIVIDUAL TOTES (for smaller production targets)

BULK STORAGE TANKS (for larger production targets)
Ammann Plant, Columbus, OH

2019 AVERAGE RAP% = 55%

60% RAP in 9.5mm Surface

70% RAP in 19.0mm Base
## EXAMPLE HIGH % RAP SURFACE AND PERFORMANCE TESTING

<table>
<thead>
<tr>
<th>DATE:</th>
<th>5/28/2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT NAME:</td>
<td>60 % RAP w/REJUVENATOR and PG 58-28 vs 25 % RAP w/PG 64-22</td>
</tr>
<tr>
<td>MIX TYPE:</td>
<td>9.5mm Surface</td>
</tr>
<tr>
<td>Mix A (50 % Binder Replacement)</td>
<td>Mix B (21 % Binder Replacement)</td>
</tr>
<tr>
<td>MIXTURE COMBINATION</td>
<td>60 % RAP w/0.10 %</td>
</tr>
<tr>
<td>TEST PROPERTY</td>
<td>(wt. of mix) REJUVENATOR and PG 58-28</td>
</tr>
<tr>
<td>IDEAL CT-INDEX</td>
<td>126.3</td>
</tr>
<tr>
<td>Disk-Shaped Compact Tension (DCT), Fracture Energy (J/m²)</td>
<td>389.7 (@ -12 C)</td>
</tr>
<tr>
<td>Hamburg Loaded Wheel Rut Depth (mm):</td>
<td>3.4 mm @ 10,000 cycles</td>
</tr>
</tbody>
</table>
Effects of Recycled Materials in Asphalt Field and Lab Operations

- Plant capabilities/issues
  - To keep sufficient RAP for higher daily mix production:
    - crushing/screening operation critical to maintain supply
  - Two RAP fractions
    - Coarse RAP (1/2" x 3/8")
    - FINE RAP (3/8" minus)
    - Typical 60-65% FRAP
    - 35-40% Coarse RAP
QC CONCERN: ASPHALT CONTENT CONCERN DUE TO HIGH RAP USE

Powerscreen: RAP % AC Higher

RAP Crushing/Screening: % AC Lower
Effects of Recycled Materials in Asphalt Field and Lab Operations

• PLANT PRODUCTION CONCERNS:
  • PLANT LIMITATIONS ON RAP %
    • RAP FEED SYSTEM
    • HEATING/DRYING RAP (HEAT TRANSFER FROM VIRGIN AGGREGATES)
    • RAP w/HIGH % MOISTURE and MAINTAINING BAGHOUSE TEMPERATURES
    • HIGH RAP % AND MAINTAINING ADEQUATE VEIL OF VIRGIN AGGREGATE IN DRUM
PLANT STORAGE TIME AND MIX TEST PROPERTIES

• DOES EXTENDED PLANT STORAGE HAVE AN EFFECT ON MIXTURE PROPERTIES?????
  • CRACK TESTING
    • IDEAL CT-INDEX
    • FLEXIBILITY INDEX
Hurstbourne Lane Laboratory Design Phase

- IDEAL CT Index = 95.3
- More absorptive dolomite coarse aggregate

<table>
<thead>
<tr>
<th>SUBLOT#</th>
<th>CT-INDEX</th>
<th>DATE</th>
<th>Time to Placement</th>
<th>NOTES:</th>
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<tbody>
<tr>
<td>1.1.5</td>
<td>125.52</td>
<td>10/29/18</td>
<td>50 min.</td>
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<td>1.2.0</td>
<td>117.65</td>
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<td>50 min.</td>
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<td>76.03</td>
<td>10/30/18</td>
<td>5 hrs.</td>
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<td>1.3.0</td>
<td>102.35</td>
<td>11/2/18</td>
<td>50 min.</td>
<td></td>
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<tr>
<td>1.3.5</td>
<td>103.90</td>
<td>11/2/18</td>
<td>50 min.</td>
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<tr>
<td>1.4.0</td>
<td>78.20</td>
<td>11/2/18</td>
<td>50 min.</td>
<td>%AC low 0.4%</td>
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<td>1.4.5</td>
<td>96.90</td>
<td>11/6/18</td>
<td>1.5 hrs.</td>
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<tr>
<td>2.1.0</td>
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<td>92.50</td>
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<tr>
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<td>3.0 hrs.</td>
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<tr>
<td>2.2.5</td>
<td>103.90</td>
<td>11/7/18</td>
<td>3.0 hrs.</td>
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<td>2.3.0</td>
<td>109.80</td>
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<td>3.0 hrs.</td>
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<td>1.5 hrs.</td>
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<td>2.4.0</td>
<td>80.90</td>
<td>11/8/18</td>
<td>1.5 hrs.</td>
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OBSERVATIONS:

1. AVERAGE CT INDEX FOR ALL SUBLOTS = 101.19
2. LOW CT-INDEX VALUE = 76.03
3. HIGH CT-INDEX VALUE = 125.52
4. FACTORS AFFECTING CT-INDEX VALUES:
   - STORAGE TIME
   - % AGGREGATE ABSORPTION CHARACTERISTICS
## 2.0 Flexibility Index (FI) Testing

The FI testing will be completed in accordance with Illinois Test Procedure 405 dated 01/01/16 available at [http://www.modot.org/business/contractor_resources/forms.htm](http://www.modot.org/business/contractor_resources/forms.htm)

<table>
<thead>
<tr>
<th>FLEXIBILITY INDEX</th>
<th>Ideal CT</th>
<th>Percent of Contract Price</th>
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<tbody>
<tr>
<td>NMAS &lt;190</td>
<td>NMAS &lt;190</td>
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<tr>
<td>&lt; 2.0</td>
<td>&lt; 32</td>
<td>98%</td>
</tr>
<tr>
<td>2.0 – 3.9</td>
<td>32 – 60</td>
<td>100%</td>
</tr>
<tr>
<td>4.0 – 7.9</td>
<td>60 - 97</td>
<td>102%</td>
</tr>
<tr>
<td>&gt;8.0</td>
<td>&gt; 97</td>
<td>103%</td>
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</table>
Effects of Recycled Materials in Asphalt Field and Lab Operations

• LAYDOWN CONCERNS (ISSUES):
  • If lower % Recycle, placement of mix is less affected
  • If high % recycle, WITHOUT ADDRESSING STIFFNESS OF MIX, the asphalt mixture will be more difficult to place/compact
    • Softer binder grade or 64-22 with rejuvenator to help
CONCLUSIONS

• Asphalt mixes utilizing recycle can be designed to accommodate even the very high RAP %’s
• Fractionating the RAP into multiple gradings gives much better control of final mixture volumetrics
• If using high recycle content the need to address hardness of the recycle binder by either softer binder grade and/or rejuvenator is there