Performance of Asphalt Mixes Containing Recycled Plastics Incorporated Using the Dry Process and Balanced Mix Design

Sagar Ghos, Christopher R. Suntier, Paul Cancino Arevalo, Syed Ashik Ali, Kenneth R. Hobson, Mushtarr Zaman, Greg Kalicki* and Darin Metzer**


BACKGROUND

- 37.5M tons of waste plastic in 2018 in the U.S.; less than 9% recycled
- Use of recycled plastics improves asphalt pavement performance and opens new market
- Recycling of plastic accounted for 28,000 jobs; $1.3B in wages; and $1.68B in revenue
- 97.4% LDPE
- No paper like film and 15.6% 15.8% Pavement with Plastic
- No sticking on pan 2.40
- 40
- 15.5/15.0 2.9
- 74.2 10
- 16.2 2.6
- Balanced Mix Design 2.375
- 0.94
- 96.5 ≤12.5 ≤12.5 2.305
- 3.5
- 77.0
- Value 145 LLDPE
- 4.10
- ≤0.80
- of plastic can be used in pavement,
- Air 12
- 2.394 1.30
- 2.304 2.313
- LDPE 2.8
- 4.10
- 77.0
- and 0.25%
- 15.7
- 96.4 15.5
- G College of Engineering, The University of Oklahoma, Norman, OK

OBJECTIVES

- Identify a suitable mixing protocol for incorporating waste plastic using dry process
- Evaluate the effect of plastic on volumetrics properties of a surface mix
- To evaluate the performances of plastic-modified asphalt mixes with respect to BMD

MATERIALS & METHODS

- Aggregate Collection
- Asphalt Binder
- LDPE
- LLDPE
- Control Mix
- Balanced Surface Mix
- Aggregate Replacement with Plastic/Dry Process
- Low-Density Polyethylene (LDPE)
- Linear Low-Density Polyethylene (LLDPE)
- Tests on Modified Mixes
  - Volumetrics
  - Hamburg Wheel Tracking (HWT)
  - Ideal Cracking Test (Ideal CT)
  - Indirect Tensile Strength (ITS) Test
- Data Analysis
  - Effect on volumetrics properties
  - Effect on cracking resistance
  - Effect on moisture induced damage resistance
  - Performance evaluation relative to BMD criteria

DESIGN OF CONTROL MIX

| TYPE OF MIX: S5 (SURFACE MIX) BINDER: PG 64-22 OPTIMUM BINDER CONTENT: 6% |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Aggregate       | % USED          |                 |                 |                 |
| 3/8" Chips      | 40              |                 |                 |                 |
| Man. Sand       | 10              |                 |                 |                 |
| 3/16" Stones    | 58              |                 |                 |                 |
| Sand            | 12              |                 |                 |                 |

PLASTIC MIXING PROTOCOL

Approach-1
- Heated Aggregate +Cold Plastic Aggregate-Plastic Mixture + Binder = Asphalt Mix
- Temperature loss No coating

Approach-2
- Aggregate + Plastic Hot Aggregate-Plastic Mixture + Hot Binder = Asphalt Mix

Approach-3
- Room Temperature Plastic Added During Mixing = Asphalt Mix
- Plastic films Plastic Sticking at Pan
  - No paper like film No sticking on pan
  - Approach-3 was finally selected

EFFECT ON VOLUMETRIC PROPERTIES

<table>
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<tr>
<th>ID</th>
<th>Gmax (mm)</th>
<th>Gmax (mm)</th>
<th>% Density</th>
<th>Air Voids</th>
<th>VMA (%)</th>
<th>VFA (%)</th>
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- Low specific gravities of plastics caused reduction in Gmax and Gah
- Higher reduction in Gah as compared to Gmax resulted in higher densities.

EFFECT ON PERFORMANCES

- Increase in rutting resistance and decrease in cracking resistance due to stiffness contributed by plastic particles
- Reduction in moisture resistance
- LLDPE is more prone to moisture induced damage

CONCLUSIONS

- Approach-3 was finally selected; adding room-temperature plastics during mixing process
- Addition of LDPE and LLDPE
- 0.25%-LLDPE and 0.25%-LLDPE modified mixes satisfied BMD criteria
- Findings can be helpful in designing plastic-modified mixes using dry process
- Future studies are needed to identify ways of incorporating higher plastics

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