# ULTRA-THIN HMA WITH RAP, FRAP, AND RAS

## A 2009 TEST CASE

ROSCOMMON COUNTY ROAD COMMISSION

# OVERVIEW

In 2009 the Roscommon County Road Commission was searching for an opportunity to experiment with Ultra-Thin HMA in an effort to reduce the overall cost per ton, while attempting to preserve the quality and effectiveness of the product on low volume Local RCRC roads. As part of a negotiated agreement with the local Asphalt producer for mining in the County R.O.W. a test case was devised. The test was to take place on a portion of a County Primary roadway serving access mainly to the producers plant location. A section of that road which was PASER rated in the 3-4 range and showed extensive distress due to Heavy truck traffic was selected.

As agreed to, the roadway was to receive additional wedging at the quarter crown in the most severely affected areas. A section approximately 1.2 miles in length was selected for resurfacing. In an effort to test the materials in loaded and unloaded conditions two sections were created. The first section on the Easterly half of the roadway was paved in both directions with Ultra-Thin HMA which contained a Tier 1 level of RAP/FRAP at a level of about 20%. The second section was paved in both directions with Ultra-Thin HMA containing RAP/FRAP and 5% maximum RAS or Recycled Asphalt Shingles. The following are the preliminary results on the durability and performance of those products after two years.

# Specific Information Related to Test Case

1) **Contractor used inferior ground shingles product in test**

This may have some bearing on the “stone” surface loss as it may not be actual stone loss but rather shingle tabs that stood up and flaked off

This may also have effected the amount of a liquid asphalt product that was activated during the production process. Large (half dollar size) tabs were found in the asphalt mix and surface following compaction

2) **Contractor production facility is a circa 1984 portable parallel flow asphalt plant with mid drum RAP induction location.**

This may effect the mixing and therefore activation and transference of RAP/RAS liquid with virgin AC and possible segregation of the RAP/RAS material within the Asphalt matrix

On site temperature of the final Asphalt mixture was within normal ranges and surface segregation was not noted in field observance

# Ultra-Thin HMA
# Medium Volume

## Virgin

| | | | | | | 64-28P | | | 58-28 |
|---|---|---|---|---|---|---|---|---|---|
| 3/8's Minus | Nat. Sand | 1/4" Dust | Man Sand | RAP | RAS | A.C Liquid | Plant Std. | Total Cost | Low/Vol. |
| 30% | 45% | 15% | 10% | 0% | 0% | 6.20% | | | 6.20% |
| $10.00 | $4.00 | $12.00 | $14.00 | $8.00 | $30.00 | $600.00 | | | $450.00 |
| $3.00 | $1.80 | $1.80 | $1.40 | $0.00 | $0.00 | $37.20 | $5.00 | $50.20 | $40.90 |

Notes:

RAS = 18-25% A.C. per/ton 30% Asbestos*

RAP = 4-5% A.C. per/ton 5% Rubber/Filler*

Polymers add about $100-$200 per A.C. Ton

Base A.C. is Close to 64-22 or 58-34 depending on Manufacturer and Base Oil

Ultra-Thin @ 83#/syd and 24' width = 585 Tons

Average Lay Down Price for Low Volume is about $58.00/ton

Average Lay Down Price for Medium Volume is about $62.00/ton

RAP = PG 82-11*

RAS = PG 126-1*

End Liquid PG? Blending Charts

# Ultra-Thin HMA
# Medium Volume

## W/RAP Tier 1

| | | | | | | 64-28P | | | 58-28 |
|---|---|---|---|---|---|---|---|---|---|
| 3/8's Minus | Nat. Sand | 1/4" Dust | Man Sand | RAP | RAS | A.C Liquid | Plant Std. | Total Cost | Low/Vol. |
| 20% | 35% | 15% | 10% | 20% | 0% | 5.30% | | | 5.30% |
| $10.00 | $4.00 | $12.00 | $14.00 | $8.00 | $30.00 | $600.00 | | | $450.00 |
| $2.00 | $1.40 | $1.80 | $1.40 | $1.60 | $0.00 | $31.80 | $5.00 | $45.00 | $37.05 |
| | | | | | | | Net Savings | $3,042.00 | $2,252.25 |

Notes:
- RAS = 18-25% A.C. per/ton
- RAP = 4-5% A.C. per/ton
- Polymers add about $100-$200 per A.C. Ton
- Base A.C. is Close to 64-22 or 58-34 depending on Manufacturer and Base Oil
- Ultra-Thin @ 83#/syd and 24' width = 585 Tons
- Average Lay Down Price for Low Volume is about $58.00/ton
- Average Lay Down Price for Medium Volume is about $62.00/ton
- RAP = PG 82-11*
- RAS = PG 126-1*
- End Liquid PG?

30% Asbestos*

5% Rubber/Filler*

Blending Charts

# Ultra-Thin HMA Medium Volume

**W/RAP/RAS = Tier 1 and 5% RAS = Tier 2 Limits** 58-34P 58-28

| 3/8's Minus | Nat. Sand | 1/4" Dust | Man Sand | RAP | RAS | A.C Liquid | Plant Std. | Total Cost | Low/Vol. |
|---|---|---|---|---|---|---|---|---|---|
| 25% | 35% | 15% | 10% | 10% | 5% | 4.50% | | | 4.50% |
| $10.00 | $4.00 | $12.00 | $14.00 | $8.00 | $30.00 | $600.00 | | | $450.00 |
| $2.50 | $1.40 | $1.80 | $1.40 | $0.80 | $1.50 | $27.00 | $5.00 | $41.40 | $34.65 |

| | | |
|---|---|---|
| Net Savings | $5,148.00 | $3,656.25 |

Notes:
- RAS = 18-25% A.C. per/ton
- RAP = 4-5% A.C. per/ton
- Polymers add about $100-$200 per A.C. Ton
- Base A.C. is Close to 64-22 or 58-34 depending on Manufacturer and Base Oil
- Ultra-Thin @ 83#/syd and 24' width = 585 Tons
- Average Lay Down Price for Low Volume is about $58.00/ton
- Average Lay Down Price for Medium Volume is about $62.00/ton
- RAP = PG 82-11*
- RAS = PG 126-1*
- End Liquid PG? Blending Charts

30% Asbestos*
5% Rubber/Filler*

## Notes:

RAS = 18-25% A.C. per/ton 30% Asbestos*

RAP = 4-5% A.C. per/ton 5% Rubber/Filler*

Polymers add about $100-$200 per A.C. Ton
Base A.C. is Close to 64-22 or 58-34 depending on Manufacturer and Base Oil

Ultra-Thin @ 83#/syd and 24' width = 585 Tons

Average Lay Down Price for Low Volume is about $58.00/ton

Average Lay Down Price for Medium Volume is about $62.00/ton

RAP = PG 82-11*

RAS = PG 126-1*

End Liquid PG? Blending Charts

Ultra-Thin HMA Medium Volume

# Actual Costs/Savings

385 Tons

| W/RAP/RAS = Tier 1 and 5% RAS = Tier 2 Limits | | | | | | 64-28P | | | 58-28 |
|---|---|---|---|---|---|---|---|---|---|
| 3/8's Minus | Nat. Sand | 1/4" Dust | Man Sand | RAP | RAS | A.C Liquid | Plant Std. | Total Cost | Low/Vol. |
| 15% | 40% | 10% | 10% | 20% | 5% | 4.00% | | | 4.00% |
| $9.00 | $3.00 | $11.00 | $12.00 | $6.00 | $28.00 | $520.00 | | | $380.00 |
| $1.35 | $1.20 | $1.10 | $1.20 | $1.20 | $1.40 | $20.80 | $4.00 | $32.25 | $26.65 |
| | | | | | | | Net Savings | $6,910.75 | $5,486.25 |

435 Tons

| W/RAP Tier 1 | | | | | | 64-28P | | | 58-28 |
|---|---|---|---|---|---|---|---|---|---|
| 3/8's Minus | Nat. Sand | 1/4" Dust | Man Sand | RAP | RAS | A.C Liquid | Plant Std. | Total Cost | Low/Vol. |
| 15% | 40% | 10% | 15% | 20% | 0% | 4.80% | | | 4.80% |
| $9.00 | $3.00 | $11.00 | $12.00 | $6.00 | $28.00 | $520.00 | | | $380.00 |
| $1.35 | $1.20 | $1.10 | $1.80 | $1.20 | $0.00 | $24.95 | $4.00 | $35.60 | $28.90 |
| | | | | | | | Net Savings | $6,351.00 | $5,220.00 |

Medium Volume HMA
*Net Savings With All Shingle
Tier 2 Mix = $.87.1/syd*

| | | |
|---|---|---|
| Total Net Savings: | $13,261.75 | $10,706.25 |
| 820 Tons | $16.17/ton | $13.06/ton |
| 16,900 syd | $.78.5/syd | $.63.4/syd |

Low Volume HMA
*Net Savings With All Shingle
Tier 2 Mix = $.64.9/syd*

Original pavement was placed on June 26, 2009 and included some quarter crown wedging and an application of 83#/syd surface course

On June 18, 2010 the first condition observation was made. Below are the distresses and frequency counts that were observed that day.

## FRAP/RAS Asphalt Material Area:

1.) Low volumes of centerline and outside edge longitudinal cracking were noted (not significant).

2.) 147 Transverse cracks were reported (most less than 6').

3.) In 3 random locations stone loss average per square yard was measured. The average was noted at 8.7 per syd.

## RAP Asphalt Material Area:

1.) Some Centerline cracking was observed with minimal edge cracking noted.

2.) 8 Transverse cracks were reported (all less than 6' in length).

3.) In 3 random locations stone loss average per square yard was measured. The average was noted at 1.7 per syd.

On June 10, 2011 the second condition observation was made. Below are the distresses and frequency counts that were observed that day.

## FRAP/RAS Asphalt Material Area:

1.) Medium volumes of centerline and outside edge longitudinal cracking were noted.

2.) 339 Transverse cracks were reported (half less than 6').

3.) In 3 random locations stone loss average per square yard was measured. The average was noted at 27.8 per syd.

## RAP Asphalt Material Area:

1.) Some Centerline cracking was observed with minimal edge cracking noted.

2.) 30 Transverse cracks were reported (all less than 6' in length).

3.) In 3 random locations stone loss average per square yard was measured. The average was noted at 3.6 per syd.

On December 6, 2011 the third condition observation was made. Below are the distresses and frequency counts that were observed that day.

## FRAP/RAS Asphalt Material Area:

1.) Medium volumes of centerline cracking and an increased amount of edge cracking were noted.

2.) 436 Transverse cracks were reported (most over 6').

3.) In 3 random locations stone loss average per square yard was measured. The average was noted at 36.3 per syd.

## RAP Asphalt Material Area:

1.) Some Centerline cracking was observed with minimal edge cracking noted.

2.) 58 Transverse cracks were reported (half less than 6' in length).

3.) In 3 random locations stone loss average per square yard was measured. The average was noted at 6.3 per syd.

# PG Grading Calculations from Blending Virgin/RAP/RAS Liquids

Assumptions:

- Northern Michigan Virgin PG Graded Bituminous Liquid requires minus 28 Degrees low end protection against thermal cracking
- Northern Michigan RAP Grading is approximately PG 82-11
- RAS Shingle Grading is approximately PG 126+1 (Tear offs)
  PG 142-11 (Waste)

North Bound Virgin Ultra-Thin


South Bound Virgin Ultra-Thin


East Bound RAP only


West Bound RAP only


East Bound with Shingles


West Bound with Shingles

## Tier 1: 17% RAP by Total Volume (20% by Weight)

| | | | |
|---|---|---|---|
| 83% = | PG 58-28 | PG 64-28P | PG 58-34 |
| 17% = | PG 82-11 | PG 82-11 | PG 82-11 |

Actual:

| | | |
|---|---|---|
| PG 62.1 - 25.1 | PG 67.1 - 25.1 | PG 62.1 - 30.1 |

## Tier 2: 18-27% RAP by Total Volume (30% by Weight)

| | | | |
|---|---|---|---|
| 73% = | PG 58-28 | PG 64-28P | PG 58-34 |
| 27% = | PG 82-11 | PG 82-11 | PG 82-11 |

Actual:

| | | |
|---|---|---|
| PG 64.5 - 23.4 | PG 68.9 – 23.4 | PG 64.5 - 27.8 |

Tier 2: 18-27% RAP/RAS by Total Volume (10% RAP / 5% RAS by Weight)

| | | | |
|---|---|---|---|
| 73% = | PG 58-28 | PG 64-28 | PG 58-34 |
| 9% = | PG 82-11 | PG 82-11 | PG 82-11 |
| 18% = | PG 126+1 | PG 126+1 | PG 126+1 |

Actual:

| | | |
|---|---|---|
| PG 72.4 - 20.4 | PG 76.8 - 20.4 | PG 72.4 - 24.8 |

*PG 58-40P
PG 82-11
PG126+1

PG 72.4 - 29.2

## Tier 3: 28% or Greater RAP by Volume (35% by Weight)

| | | | |
|---|---|---|---|
| 70% = | PG 58-28 | PG 64-28P | PG 58-34 |
| 30% = | PG 82-11 | PG 82-11 | PG 82-11 |

## Actual:

| | | |
|---|---|---|
| PG 65.2 - 22.9 | PG 69.4 - 22.9 | PG 65.2 - 27.1 |

Tier 3: 28% or Greater RAP/RAS by Total Volume (20% RAP / 5% RAS by Weight)

| | | | |
|---|---|---|---|
| 65% = | PG 58-28 | PG 64-28P | PG 52-34P |
| 17% = | PG 82-11 | PG 82-11 | PG 82-11 |
| 18% = | PG 126+1 | PG 126+1 | PG 126+1 |

Actual:

| | | |
|---|---|---|
| PG 74.3 - 19.9 | PG 78.2 - 19.9 | PG 70.4 - 23.8 |
| | | PG 52-40P<br>PG 70.4-27.7 |

# Using RAP/FRAP/RAS in Thin Overlays

1) I would recommend a higher Asphalt content in the mix to assure minimum film thickness on all aggregates

2) I would not allow counting all the liquid tested as usable, activated virgin material

3) I would recommend a thorough crack sealing of the pavement prior to resurfacing

4) I would recommend using a Polymer (not acid) modified Asphalt Binder with a low end temperature at least one step down from your standard material. Two steps down if using Shingles

5) I would specify the Medium Volume Ultra-Thin not so much for the crush count but for the improved PG grading of the liquid

# Questions ???