Ten Years of Experience with RAS in City of Edmonton Asphalt Mixes

Hugh Donovan, P.Eng.
Leonard Dunn, P.Eng.
Nawaz Panhwer, P.Eng.
What is RAS?

➔ Recycled Asphalt Shingles
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- Recycled Asphalt Shingles
  - Shredded materials from roofing industry
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  - Pre-consumer shingle material “Tabs”
What is RAS?

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- Shredded materials from roofing industry
- Pre-consumer shingle material “Tabs”

- Consists of roll ends, non-compliant shingles (off colour, damage, etc.), production waste materials, etc.
Recycled Asphalt Shingles
Shredded materials from roofing industry
Pre-consumer shingle material “Tabs”
Consist of roll ends, non-compliant shingles (off colour, damaged), waste materials
Comes directly from the shingle manufacturer
What is RAS?

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- Pre-consumer shingle material “Tabs”
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- Comes directly from shingle manufacturer

→ Not previously used
What is RAS?

- Recycled Asphalt Shingles
- Shredded materials from roofing industry
- Pre-consumer shingle material “Tabs”
- Post-consumer shingle material “Tear-Offs”
What is RAS?

- Recycled Asphalt Shingles
- Shredded materials from roofing industry
- Pre-consumer shingle material “Tabs”
- Post-consumer shingle material “Tear-Offs”

⇒ Shingles torn off buildings during re-roofing
Processing Shingle Tabs
Processing Shingle Tabs
Processing Shingle Tabs
RAS Stockpile
Processed RAS
What is RAS?

- Recycled Asphalt Shingles
  - Contains same basic ingredients as HMA
What is RAS?

- Recycled Asphalt Shingles
- Contains same basic ingredients as HMA
  - Asphalt Binder
What is RAS?

- Recycled Asphalt Shingles
- Contains same basic ingredients as HMA
- Asphalt Binder
  - Highly Oxidized
  - 25 – 40 percent of shingle
What is RAS?

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- Contains same basic ingredients as HMA
- Asphalt Binder
- Sand and Mineral Filler
What is RAS?

- Recycled Asphalt Shingles
- Contains same basic ingredients as HMA
- Asphalt Binder
- Sand and Mineral Filler
  - Fine grained Sand
  - Very fine grained Mineral Filler
  - 45 – 65 percent of shingle
What is RAS?

- Recycled Asphalt Shingles
- Contains same basic ingredients as HMA
- Asphalt binder (although highly oxidized)
- Sand and Mineral Filler
  - Fibers
Recycled Asphalt Shingles
Contains same basic ingredients as HMA
Asphalt binder (although highly oxidized)
Sand and Mineral Filler
Fibers
  ➔ Cellulose or Glass
  ➔ 5 – 20 percent of shingle
What is RAS?

- Recycled Asphalt Shingles
- Contain same basic ingredients as HMA
- Asphalt binder (although highly oxidized)
- Sand and Mineral Filler
- Fibers

Cautionary Note: Older “Tear-Offs” may contain Asbestos fibers
RAS History

First started to be used in North American HMA mixes in the early to mid 1990’s
RAS History

- First started to be used in North American HMA mixes in the early to mid 1990’s
  - Canada 1994
    - Regional Road 41, Regional Municipality of Ottawa-Carlton, ~1500 tonnes
  - Alberta 2003
    - 184 Street Project for the City of Edmonton
Edmonton’s RAS Experience

☞ 184 Street – Yellowhead Trail Grade Separation Project Roadwork
184 Street – Yellowhead Trail Grade Separation Project Roadworks

- Tendered August, 2003
- 50,000 tonnes Asphalt Concrete Base (ACB)
- 20,000 tonnes Asphalt Concrete Overlay (ACO)
Edmonton’s RAS Experience
Edmonton’s RAS Experience
Edmonton’s RAS Experience

- 184 Street – Yellowhead Trail Grade Separation Project Roadwork
  - Wells Construction Ltd., a Division of Lafarge Canada Inc.
  - Contract award on August 19, 2003
Edmonton’s RAS Experience

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- Wells Construction Ltd., a Division of Lafarge Canada Inc.
  - Fall, 2003 requested they be allowed to use RAS in the ACB mix
Edmonton’s RAS Experience

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- Wells Construction Ltd., a Division of Lafarge Canada Inc.
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  - RAS identified as Manufactured Shingle Modifier (MSM)
Edmonton’s RAS Experience

- 184 Street – Yellowhead Trail Grade Separation Project Roadworks
- Wells Construction Ltd., a Division of Lafarge Canada Inc.
- Fall, 2003 requested they be allowed to use RAS in the ACB mix
- RAS identified as Manufactured Shingle Modifier (MSM)
- Permitted to produce & place ACB test mixes with RAS
Edmonton’s RAS Experience

Test Mixes to Evaluate Performance
Edmonton’s RAS Experience

- Test Mixes to Evaluate Performance
  - ACB mixes with:
    - Reclaimed Asphalt Pavement (RAP)
    - RAS/RAP blend
    - 10 percent recycled materials
Edmonton’s RAS Experience

- Test Mixes to Evaluate Performance
- ACB mixes with:
  - Reclaimed Asphalt Pavement (RAP)
  - RAS/RAP blend
    - Mix 1, 25/75 RAS/RAP = 2.5 percent RAS
    - Mix 2, 50/50 RAS/RAP = 5.0 percent RAS
    - Mix 3, 0/100 RAS/RAP – Control Section
  - 10 percent recycled materials
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
  - Field and Laboratory evaluation of 3 mixes
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Field and Laboratory Evaluation of 3 mixes

- Mix Properties Evaluated:
  - Recovered Binder Superpave PG grading
  - Recovered Binder Critical Cracking Temperature
  - Mix Critical Cracking Temperature
  - Mix Rutting Resistance
  - Mix Compactability
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Field and Laboratory Evaluation of 3 mixes
- Mix Properties Evaluated:
  - Recovered Binder Superpave PG grading
    - Abson recovery of binder from field produced mix
  - Superpave Grading via AASHTO MP1
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Field and Laboratory Evaluation of 3 mixes
- Mix Properties Evaluated:
  - Recovered Binder Critical Cracking Temperature
    - AASHTO T314 – Determining the Fracture Properties of Asphalt Binder in Direct Tension
    - Direct Tension Test (DTT)
  - Creep stiffness & failure strain
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Field and Laboratory Evaluation of 3 mixes
- Mix Properties Evaluated:
  - Mix Critical Cracking Temperature
  - Field produced mix
  - Compacted in SGC to 7.0 +/- 1.0 % air voids
  - AASHTO T322 – Creep Compliance & Strength using the Indirect Tensile Strength Testing Device
  - Utilized Dr. Christensen’s methodology
Edmonton’s RAS Experience

AASHTO T322 Test Configuration
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Field and Laboratory Evaluation of 3 mixes
- Mix Properties Evaluated:
  - Mix Rutting Resistance
    - Field produced mix
    - Compacted in SGC to 7.0 +/- 0.5 % air voids
    - AASTHO TP63 – Asphalt Pavement Analyzer (APA)
    - 52°C test temperature
    - 8,000 cycles
Edmonton’s RAS Experience

AASHTO TP63 APA
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Field and Laboratory Evaluation of 3 mixes
- Mix Properties Evaluated:
  - Mix Compactability
    - Field produced & compacted mix
    - Gmm or MTD
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Study Results
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Study Results
  - Recovered Binder Superpave PG grading
    - Mix 1 (25% RAS/75% RAP) PG 64-28 (66-32)
    - Mix 2 (50% RAS/50% RAP) PG 70-28 (73-29)
    - Mix 3 (0% RAS/100% RAP) PG 58-28 (61-32)
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Study Results
  - Recovered Binder Critical Cracking Temperature
    - Mix 1 (25%RAS/75%RAP) -32.8°C (PG 66-33)
    - Mix 2 (50%RAS/50%RAP) -28.6°C (PG 73-29)
    - Mix 3 (0%RAS/100%RAP) -32.2°C (PG 61-32)
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Study Results

  - Mix Critical Cracking Temperature
    - Mix 1 (25% RAS/75% RAP) -25.3°C
    - Mix 2 (50% RAS/50% RAP) -28.5°C
    - Mix 3 (0% RAS/100% RAP) -30.5°C
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Study Results
  - Mix Rutting Resistance
    - Mix 1 (25% RAS/75% RAP) 4.8 mm
    - Mix 2 (50% RAS/50% RAP) 3.9 mm
    - Mix 3 (0% RAS/100% RAP) 2.7 mm
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Study Results
  - Mix Compactability
    - Mix 1 (25% RAS/75% RAP) - 99.4% Marshall - 95.4% MTD
    - Mix 2 (50% RAS/50% RAP) - 100.1% Marshall - 95.0% MTD
    - Mix 3 (0% RAS/100% RAP) - 99.7% Marshall - 96.5% MTD
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Study Conclusions
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Study Conclusions
  - Addition of RAS/RAP had a significant reduction in APA rutting
  - Historic ACB - 11.3 mm
  - Enhanced Crush Count ACB - 9.0 mm
  - RAS/RAP mixes - 4.8 & 3.9 mm
  - RAP mix - 2.7 mm
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Study Conclusions
  - Addition of RAS/RAP had a significant reduction in APA rutting
  - Notwithstanding some variability in results, the 25%RAS/75%RAP combination did not significantly reduced the low temperature susceptibility of the mix/binder
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Study Conclusions
  - Addition of RAS/RAP had a significant reduction in APA rutting
  - Notwithstanding some variability in results, the 25%RAS/75%RAP combination did not significantly reduced the low temperature susceptibility of the mix/binder
  - There was a more pronounced increase in the high temperature PG grading with increasing amounts of RAS
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Study Conclusions
  - The RAS/RAP mixes were readily compactable
  - > 99 percent Marshall compaction
  - > 95 percent MTD compaction
Edmonton’s RAS Experience

- Study to Evaluate Mix Material Properties
- Study Conclusions
  - Contractor was allowed to use 10 percent RAS/RAP in ACB mix for remainder of 184 Street – YHT project
  - RAS content was limited to 3 percent or an equivalent 30%RAS/70%RAP ratio
  - ~36,000 tonnes ACB placed in 2004
Edmonton’s RAS Experience

- **Study to Evaluate Mix Material Properties**
- **Study Conclusions**
  - 2007 City starting accepting RAS/RAP in ACB, ACO, and ACR mixes
  - Maximum amount of RAS remained at 3 percent
  - Maximum RAP and RAS/RAP content for
    - ACB 25 percent
    - ACO 10 percent
    - ACR 20 percent
  - No change in mix Void properties
Edmonton’s RAS Experience

Field Performance
Edmonton’s RAS Experience

Field Performance

2007 to 2009 – 14 projects

• 200,000 tonnes ACO
• 60,000 tonnes ACR
• 26,000 tonnes ACB
Edmonton’s RAS Experience

Field Performance

- 2009 – Moisture Induced Stripping Study
- All mixes to contain 0.3 percent anti-stripping agent from August 2009 onward
- All future mixes to meet a TSR minimum of 75 percent with amount of anti-stripping agent to be determined by the mix design
Edmonton’s RAS Experience

Field Performance

2010 to 2011 – 20 projects

- 88,000 tonnes ACO
- 160,000 tonnes ACR
- 40,000 tonnes ACB
Edmonton’s RAS Experience

Field Performance

- 2010 to 2011 TSR results - mixes with RAS consistently appeared visually “drier” than comparable virgin mixes
Edmonton’s RAS Experience

Field Performance

ACO – RAP only - TSR samples
Edmonton’s RAS Experience

❖ Field Performance

★ ACO - RAS/RAP - TSR samples
Edmonton’s RAS Experience

Field Performance

- 2012 specification changes
  - RAS stockpiling and testing requirements
  - 0.5 percent reduction in design Air Void content for mixes containing RAS
  - Ratio of virgin binder to total binder content is > 80% for “surface” mixes and > 75% for “non-surface” mixes
Edmonton’s RAS Experience

Field Performance

✧ 2012 – 3 projects
  • 12,000 tonnes ACO
  • 4,000 tonnes ACB
✧ 2013 – 0 Projects
Edmonton’s RAS Experience

- Field Performance
  - October, 2013 visual assessment of performance
  - All projects in which RAS mix at surface
Edmonton’s RAS Experience

Field Performance

2007 – ACO RAS – 118 Ave., W /170 St.
Edmonton’s RAS Experience

Field Performance

² 2008 – ACO RAS – Fort Road, N /66 St.
Edmonton’s RAS Experience

Field Performance

Edmonton’s RAS Experience

Field Performance

2011 – ACO RAS – Lessard Road, W./TUC
Edmonton’s RAS Experience

Field Performance

✧ For the most part, mixes are performing well
✧ Some area of moderate to severe ravelling
Field Performance

- For the most part, mixes are performing well
- Some area of moderate to severe ravelling
  - Deficient in binder by 0.4 to 0.7 percent
  - Field air voids between 8.5 to 12.0 percent
Edmonton’s RAS Experience

- Field Performance
  - For the most part, mixes are performing well
  - Some area of moderate to severe ravelling
  - Some are of slight ravelling confined to construction & longitudinal joints
Edmonton’s RAS Experience

✧ Field Performance
✧ For the most part, mixes are performing well
✧ Some area of moderate to severe ravelling
✧ Some are of slight ravelling confined to construction & longitudinal joints
✧ Mix not immune to reflective cracking from underlying cracks
Edmonton’s RAS Experience

- Field Performance
  - For the most part, mixes are performing well
  - Some area of moderate to severe ravelling
  - Some are of slight ravelling confined to construction & longitudinal joints
  - Mix not immune to reflective cracking from underlying cracks
  - No low temperature transverse cracks on new construction with RAS/RAP mix
Edmonton’s RAS Experience

Thank you

Questions ???