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Works Alberta Ltd.

Thin Hot Mix Asphalt Surfacing System
Presentation Outline

- Expected characteristics of surfacing course
- Thin hot mix asphalt surfacing systems
- Dense graded mixtures
- Gap graded mixtures
- Tacking/bonding techniques
- Surface characteristics of thin surfacing course
- Objectives & constraints
Expected Characteristics

- **Safety**
  - adequate friction
  - absence of rutting
  - reduce water spray
  - reduce glare
  - facilitate visibility

- **Comfort**
  - good smoothness
  - reduce rolling noise

- **Performance**
  - resist aggression
    - deicing agent and winter sand
    - snow plow blades
  - seal structure
Thin Hot Mix Asphalt Surfacing Systems

- **Thickness**
  - NAPA - 12.5 mm to 37.5 mm

- **Systems available**
  - dense graded: Marshall or Superpave
  - gap graded: SMA or Novachip
  - low noise HMA systems

- **Usages**
  - preventive maintenance
  - surface characteristics restoration
  - rehabilitation
  - construction
Gap Graded vs. Dense Graded

Stone Matrix Asphalt SMA

Conventional Hot Mix Asphalt HMA
Gap Graded vs. Dense Graded
Stone mastic asphalt

Fine-graded mix

Coarse-graded mix

Gradations

Sieve size raised to 0.45 power

% Passing

Max. density line

NMAS

Porous asphalt

PCS

NMAS

8/6 mm SMA

50 mm SMA
Dense Graded Mixtures

- Conventional technology
  - *mix-design development*
    - *Superpave or Marshall*
  - *smaller NMAS (Nominal Maximum Aggregate Size)*
    - *typically < 10 mm*

- Surface characteristics
  - *smooth surface*
    - *well suited for urban and suburban settings*
  - *reduction in rolling noise*
    - *uniform surface texture*
Dense Graded Mixtures

• Engineering of dense graded small size NMAS
  o *bitumen – neat and polymer-modified asphalt*
  o *mineral aggregate - high crushed count*
  o *NMAS: 4.75, 5.0, 6.3 and 9.5 mm*

• Mix-design method
  o *Superpave or Marshall*
  o *performance-based rutting criteria (if required)*

• Application
  o *require tack-coating*
  o *thickness applied ~ 20 to 30 mm*
  o *placed using conventional equipment*
### Expected Mixture Properties

<table>
<thead>
<tr>
<th>NMAS</th>
<th>12.5 mm</th>
<th>9.5 mm</th>
<th>6.3 mm</th>
<th>4.75 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agency</td>
<td>Alabama</td>
<td>North Carolina</td>
<td>Nevada</td>
<td>Utah</td>
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<tr>
<td>Gradation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sieve Size</td>
<td>% Passing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 mm</td>
<td>100</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.5 mm</td>
<td>90 - 100</td>
<td>85 - 100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>9.5 mm</td>
<td>&lt;90</td>
<td>60 - 80</td>
<td>85 - 100</td>
<td>90 - 100</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>28 - 38</td>
<td>50 - 75</td>
<td>&lt;90</td>
<td>80 - 100</td>
</tr>
</tbody>
</table>

### Mix Design

<table>
<thead>
<tr>
<th></th>
<th>N&lt;sub&gt;design&lt;/sub&gt;</th>
<th>Design Air Voids</th>
<th>%VMA</th>
<th>%VFA, range</th>
<th>Asphalt Content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60</td>
<td>3 - 6</td>
<td>15.5 min</td>
<td>70 - 80</td>
<td>5.5 min</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>3.5</td>
<td>12 - 22</td>
<td>70 - 78</td>
<td>4.6 - 5.6</td>
</tr>
<tr>
<td></td>
<td>50 to 122&lt;sup&gt;3&lt;/sup&gt;</td>
<td>4.0</td>
<td>16 min</td>
<td>50 - 80</td>
<td>5.0 - 8.0</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>4.0</td>
<td></td>
<td>50</td>
<td>6.0 - 7.5</td>
</tr>
<tr>
<td></td>
<td>50/65&lt;sup&gt;4&lt;/sup&gt;</td>
<td>4.0 - 7.0</td>
<td></td>
<td>50/75&lt;sup&gt;4&lt;/sup&gt;</td>
<td>6.4 min</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>3.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>50/75&lt;sup&gt;4&lt;/sup&gt;</td>
<td>3.5</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

1. Low or Medium Volume/High Volume
2. Carbonate/Other Aggregates
3. N<sub>design</sub> based on traffic level
Front Street Paving in Dawson City
September 21, 2009
Globe & Mail

Why not pave the streets with gold? Oh, right
Dawson City, Yukon
Gap Graded Mixtures

• Heavy duty surfacing system
  o improve resistance to permanent deformation
    ➢ strong aggregate interlock
  o excellent durability
    ➢ binder-rich material

• Premium surface characteristics
  o excellent visibility
    ➢ more water held within the mixture surface texture
  o reduction in rolling noise
    ➢ surface texture is deep and uniform
SMA – 0/6 mm

- Engineering of SMA 0/6 mm
  - bitumen - polymer-modified
  - mineral aggregate - high crushed count

- Mix-design method
  - mainly gyratory compactor
  - performance-based rutting criteria - wheel tracking device

- Application
  - require tack-coating
  - minimum thickness applied ~ 20 mm
  - placed using conventional equipment
Rut Testing Device
### Typical Mixture Properties

<table>
<thead>
<tr>
<th>Criteria</th>
<th>JMF</th>
<th>Requirements</th>
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</thead>
<tbody>
<tr>
<td><strong>Bitumen content/volume</strong></td>
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<td></td>
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<tr>
<td>PG70-28P</td>
<td>5.8 %</td>
<td>-</td>
</tr>
<tr>
<td>$V_{be}$</td>
<td>12.6 %</td>
<td>-</td>
</tr>
<tr>
<td><strong>Volumetric properties</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N_{ini}$ (10 Gyr.)</td>
<td>14.5%</td>
<td>$\geq 11.0$ %</td>
</tr>
<tr>
<td>$N_{des}$ (80 Gyr.)</td>
<td>5.5 %</td>
<td>4.0 to 7.0 %</td>
</tr>
<tr>
<td>$N_{max}$ (200 Gyr.)</td>
<td>2.4 %</td>
<td>$\geq 2.0$ %</td>
</tr>
<tr>
<td>VMA</td>
<td>18.1 %</td>
<td>17.0 %</td>
</tr>
<tr>
<td>VCA</td>
<td>38.2 %</td>
<td>$&lt; 44.8^*$</td>
</tr>
<tr>
<td><strong>Moisture resistance &amp; draindown properties</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSR</td>
<td>92.8 %</td>
<td>$&gt; 70.0$ %</td>
</tr>
<tr>
<td>Draindown</td>
<td>0</td>
<td>$&lt; 0.3$ %</td>
</tr>
</tbody>
</table>
## Rutting Resistance Characteristics

<table>
<thead>
<tr>
<th>Criteria</th>
<th>JMF</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000 cycle @ 60°C</td>
<td>4.5 %</td>
<td>&lt; 10 %</td>
</tr>
<tr>
<td>3,000 cycle @ 60°C</td>
<td>5.2 %</td>
<td>&lt; 20 %</td>
</tr>
<tr>
<td>30,000 cycle @ 60°C</td>
<td>7.3 %</td>
<td>-</td>
</tr>
</tbody>
</table>
After Construction
One Year Later
Surface Texture

1 week

1 year
Four Years Later
Novachip

Novachip is a thin pavement surfacing system which involves the embedment of a gap-graded HMA in an uniformed thick bond coat. The bond-coat migrates upwards one third of the thickness of the HMA resulting in an excellent bond with the underlying surface.
Novachip

- Total Depth: 15 mm
- Agg. Max. Size: 10 mm
- Bond-Coat Height: 5 mm
Novachip
Novachip

- **Materials**
  - *bitumen – preferably polymer-modified*
  - *mineral aggregate – high crushed count*
  - *bond coat – polymer-modified emulsion*

- **Mix-design method**
  - *strong focus on film thickness*

- **Types** - 0/6 mm, 0/10 mm & 0/14 mm

- **Application**
  - *thick polymer-modified bond coat*
  - *minimum thickness applied ~ 15 mm*
  - *placed using specific equipment*
HMA is placed in a single pass with a specialized paver that combines the functions of a distributor and HMA lay down machine.

Once place the HMA is seated in bond-coat using steel rollers.
Tacking/Bonding Techniques

• Provide lamination i.e. bonding between two layers of HMA
  - pavement structural design aspects
    - essential for long term performance
    - prevent ingress of water

• Facilitate placement for thin HMA
  - anchors mix during lay down and compaction
Paving

Conventional Paving Thickness
Asphalt Institute Recommendation
3 to 4 x NMAS
"f_{substrate} " may be influence by the type, quality and performance of tack/bond coat

\[ f_{screed} < f_{substrate} \]
Tacking/Bonding Techniques

- Novachip like system
Tacking/Bonding Techniques

- Trackless tack-coat
Tacking/Bonding Techniques

- SAMIs
Fibre-Reinforced Membrane

- HMA
- Protective Chippings
- Binder & Fibres
- Substrate

Fibre-reinforced bond coat with protective chippings - SAMI
Tacking/Bonding Techniques

- Asphalt emulsion
  - *no solvent*

- Engineered for application
  - *low viscosity - uniformity*
  - *heavier residual - thin overlays*
  - *polymer-modified - better bond*
  - *additives - fast break*
  - *hardest of residual binder – tracklessness*
  - *fibers – cracking mitigation*
Surface Characteristics

- **Surface friction**
  - *usage of a good aggregate*
  - *skid number of 50*
- **Surface drainage**
  - *macro-texture depth of 0.6 to 1.0 mm*
- **Smoothness**
  - *placed with modern paving and compaction equipment*
- **Rutting defects**
  - *wheel tracking laboratory tested for rut resistance*
- **Rolling noise reduction**
  - *negative texture*
  - *short surface wave length (NMAS < 10 mm)*
  - *high surface voids*
# Objectives & Constraints

## Thin HMA systems

<table>
<thead>
<tr>
<th>Safety</th>
<th>Esthetics</th>
<th>Noise reduction</th>
<th>Anti-rutting</th>
<th>Density Graded Mixes &lt; 8 mm</th>
<th>Thickness &lt; 25 mm</th>
<th>Aggressive traffic</th>
<th>Rapidity of placement</th>
<th>Profiling capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>**</td>
<td>**</td>
<td>*</td>
<td>Dense Graded Mixes &lt; 8 mm</td>
<td>√</td>
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</tr>
<tr>
<td>****</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>SMA 0/6 mm</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>****</td>
<td>**</td>
<td>**</td>
<td>***</td>
<td>SMA 0/10 mm</td>
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<tr>
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<td>***</td>
<td>***</td>
<td>Novachip 0/6 mm</td>
<td>√</td>
<td>√</td>
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<td>√</td>
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<tr>
<td>****</td>
<td>**</td>
<td>**</td>
<td>***</td>
<td>Novachip 0/10 mm</td>
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<tr>
<td>**</td>
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<td>Low noise HMA systems</td>
<td>√</td>
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</table>
Summary

• Suitable for all volume highways
• Rapid operation
• No chip loss
• Resistant to mat damage caused by turning and braking
• Reshaping capacity
• High skid resistance
• Aggressive macrotexture
• Strong adhesion to existing pavement
• Reduced rolling noise
• Bond-coat seals existing surface