Dust Control on Forest Roads

Webinar
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Project Background

Objective:
- Study the cost effectiveness of annual dust control treatments on the life of wearing course materials
Project Background

- Collaboration between FPInnovations, Adams Lake Division of Interfor Corporation, and the Engineering Branch of Ministry of Forests, Lands, and Natural Resource Operations (FLNRO)

- Literature review of gravel loss studies

- Five years of monitoring road performance and aggregate deterioration on test sections built on the Adams West Forest Service Road (FSR)
Content

- Why use dust control?
- Dust control versus stabilization
- Available products
- How hygroscopic products work
- Adams Lake site
- Treatment application
- Safety benefits
- Safety concerns
- Travel speeds
- Road performance (URCI)

- Gravel loss
- Aggregate gradation
- Maintenance
- Lifecycle costing
- Influence of gravel quality
- Application methodology
- Watering and grading practices
- Application recommendations
- Conclusions
Why Use Dust Control?

- Improve health and safety
  - Improve visibility and air quality
- Increase road surface density and cohesion
- Reduce aggregate loss
  - Raveling, wear, loss of fines, etc.
- Reduce grading requirements
- Improve transportation efficiency
# Dust Control versus Stabilization

<table>
<thead>
<tr>
<th></th>
<th>Dust palliatives</th>
<th>Stabilizers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduces dust effectively</td>
<td>Yes!</td>
<td>Not all products will</td>
</tr>
<tr>
<td>Strength</td>
<td>No mechanical bonds between particles, little to no improvement in strength</td>
<td>Mechanical bonds between particles increases strength</td>
</tr>
<tr>
<td>Life span</td>
<td>Short (usually one season)</td>
<td>Medium to long, especially full depth reclamation</td>
</tr>
<tr>
<td>Cost</td>
<td>Lowest</td>
<td>Highest</td>
</tr>
<tr>
<td>Application</td>
<td>Usually easy to apply, often by topical spray</td>
<td>Some products can be applied as topical spray but most require mixing for better results</td>
</tr>
<tr>
<td>Quality control</td>
<td>Controlled application rate, moisture, road preparation and compaction is recommended</td>
<td>Most stabilizers require more attention (controlled moisture content, compaction in layers, mixing, etc.)</td>
</tr>
<tr>
<td>Rejuvenation</td>
<td>Reapplication or rejuvenation (water) may be required during late summer depending on traffic and climate</td>
<td>Reapplication or rejuvenation is sometimes required/recommended during summer depending a product</td>
</tr>
<tr>
<td>Road maintenance</td>
<td>Most products can be graded without losing effectiveness</td>
<td>Most will lose effectiveness (on the surface) following grading (bonds are broken)</td>
</tr>
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Available Products

More than 400 products available commercially

<table>
<thead>
<tr>
<th>Dust palliatives – dust suppression</th>
<th>Stabilizers – strength improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hygroscopic salts</td>
<td>Tars and bitumens</td>
</tr>
<tr>
<td>Water and wetting agents</td>
<td>Synthetic polymer emulsions</td>
</tr>
<tr>
<td>Natural polymers</td>
<td>Sulphonated oils</td>
</tr>
<tr>
<td>Synthetic polymer emulsions</td>
<td>Lime and cement</td>
</tr>
<tr>
<td>Modified waxes</td>
<td>Enzymes and biological agents</td>
</tr>
<tr>
<td>Petroleum resins</td>
<td></td>
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</table>
How Hygroscopic Materials Work

- Hygroscopic products attract moisture from the air to create a thin film of moisture and help keep the road surface dense and smooth.
Study Site: Adams Lake

Interfor Mill

South Pit

North Pit

1a

1b

1c

2a

2b

3a

3b

3c
Treatment Application

- Application rate of 1 L/m² during late spring or early summer
- Year 1: material treated in two layers
  - Each lift 75 mm crushed aggregate
- Years 2 - 4: surface treated with topical spray/mix
- Section treatment regime
  - Annually
  - Biennially (every two years)
  - No treatment (control section)
Safety Benefits

- Conducted survey of 33 road users
- 88% believed safety has improved since dust control treatment
  - Tighter, smoother road surface
- Visibility restored in 2-4 seconds on treated road sections
  - Up to 90 seconds on untreated sections

Low to moderate dust cloud on Test Section 2B in July 2013.
Safety Concerns

- Increased public traffic volume and speeds
  - Public do not possess two-way radios
- Treated road surface can become slippery when wet in sections with high fines content
  - No reported safety incidents yet
  - Must drive to road conditions

Light corrugations were recorded on most test sections (e.g. Section 3A in September 2014).
Travel Speeds

- Increased visibility and road surface condition promote faster travel

- Adams West - Treated
  - South: 5 km/h faster
  - North: 3.5 km/h faster

- Adams East - Treated
  - Speed increase of up to 10 km/h
Unsurfaced Road Condition Index (URCI)
Gravel Loss (Surface Elevation)

- No notable difference in elevation change between treated and untreated road surfaces
- Gravel wear was not found to be reduced with road stabilization
  - Dust control may not prolong aggregate life
Recommended Wearing Course Gradation

- **Coarse mixture, difficult to shape and compact, higher roughness**
- **Open texture, loose material, prone to corrugation under traffic**
- **Unstable when wet and requires stabilization**
- **Slippery when wet and dusty when dry**

*Particle size (mm)*

*Total % passing*
South versus North Pit Gradation

**Initial gradation**
- Excellent
- Good

<table>
<thead>
<tr>
<th>% fines</th>
<th>South</th>
<th>North</th>
</tr>
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<tbody>
<tr>
<td>11.1</td>
<td>9.6</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% fine sand (passing 0.425 mm)</th>
<th>South</th>
<th>North</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>27</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Plasticity index</th>
<th>South</th>
<th>North</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>30</td>
<td></td>
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<table>
<thead>
<tr>
<th>Micro-Deval abrasion resistance (%)</th>
<th>South</th>
<th>North</th>
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<tbody>
<tr>
<td>9</td>
<td>15</td>
<td></td>
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Evolution of Gradation Over Time – South Pit

Graph showing the evolution of particle size distribution over time in the South Pit, with curves indicating different years and gradation limits.
Maintenance

- Grading triggered by presence of surface distress
- Direct correlation to traffic volume
- Did not see change in surface condition or grading frequency
- Grading shifted seasons after dust treatment
  - Less in summer, more in winter
  - Believed to have slowed freeze up, promoted thawing
  - Same number of grading interventions annually
Lifecycle Costing

- Expected to see savings through reduced maintenance and longer gravel life
- Costs:
  - Dust control, maintenance, haul savings to reach neutral cost
- Can be cost-neutral on lower volume roads
- Can result in savings on higher traffic roads
Lifecycle Costing

- Annual savings in haul costs on Adams West:
  - South: $4100/km
  - North: $950/km
## Lifecycle Costing

<table>
<thead>
<tr>
<th></th>
<th>Scenarios</th>
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<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td><strong>Road upgrade cost ($/km) (lasts 10 years)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$25,000</td>
</tr>
<tr>
<td><strong>Dust control cost ($/km/year)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Aggregate quality</strong></td>
<td>Good</td>
</tr>
<tr>
<td><strong>Average summer log hauling truck travel speed (km/h)</strong></td>
<td>45</td>
</tr>
<tr>
<td><strong>Annual road maintenance cost ($/km/year)</strong></td>
<td>$8,000</td>
</tr>
<tr>
<td><strong>10-year NPV transportation cost (includes log hauling and road maintenance costs) ($/km)</strong></td>
<td>$783,537</td>
</tr>
<tr>
<td><strong>10-year NPV transportation cost difference (taking Scenario A as a baseline) ($/km)</strong></td>
<td></td>
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</tbody>
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Application Methodology

- Application rate of 1 L/m²
- **CaCl₂** and **MgCl₂** can leach from road surface in heavy rain
  - Heavy watering not recommended
- Treatments also perform poorly in prolonged dry spells
  - Watering may be necessary
Watering and Grading Practices

- If road becomes dusty during dry period, rejuvenate treatment with water @ 0.45 to 0.9 L/m²
- Treated surface can be graded without losing effectiveness
- Multiple applications of water needed to make surface workable (@ 0.45 to 0.9 L/m²)
Application Recommendations

- Avoid application over poorly-graded material (insufficient fines content)
- Perform an effective grading (reshaping) prior to application
- Ensure thorough mixing (with grader)
- Adequate drainage (proper crown) a key factor of long-term results
Application Recommendations

- Follow the supplier's recommended application rate and double check with published specs
- Compaction recommended when possible
- After application, AVOID grading during dry periods
- Some products may require a cure period
Conclusions

- Road user safety
  - 88% of participants say road is safer
- URCI: no significant difference in condition measured
- No elevation difference measured between treated and untreated
- Reduction in gravel wear was not confirmed
- Travel speeds increased on treated roads
Conclusions

- Cost effectiveness
  - Estimated yearly savings due to speed increases:
    - South: $4100/km (high traffic)
    - North: $950/km (low traffic)
  - Savings of approx. $115,000/km per 10 years using dust control, high quality aggregate, and road upgrading
- Higher quality aggregate may be more effective at improving road performance and prolonging road longevity than applying dust control
- Hypothesis that dust control can prolong road life by twofold could not be confirmed in the 5-year study
Thank you / Questions?

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