The Battle of Alberta
COLD IN PLACE RECYCLING
A Greener Approach
For The City Of Calgary Pavement Rehabilitation

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- Christine Geuder, Summer Student
Outline

- Introduction
- Project Background
  - The Problem
  - Analyzing the Problem
  - Fixing the Problem
- Post Treatment Testing and Performance
- Summary
- Questions
Introduction
CIR Process

Hose connection to the bitumen tanker
Hose connection to the water tanker
Microprocessor-controlled pump for injecting water for compaction
Microprocessor-controlled pump for injecting hot bitumen

Working direction

Spreader auger
Tamping screed

Damaged asphalt pavement
Milling and mixing rotor
Prepared mixture of materials

Water tanker
Bitumen tanker
2200 CR: milling, mixing, placement and precompaction
Introduction – Some of the benefits

Green House Gas Emissions by Different Paving Processes
(Chehovits and Galehouse)

Green House Gas Emissions (Lb CO₂/T)

- Hot Mix AC
- Warm Mix AC
- Plain PCC
- CRCP
- HIR
- CIR

Paving Process
Introduction –
Some of the benefits

Energy Use by Different Paving Processes
(Chehovits and Galehouse)

![Energy Use by Different Paving Processes](image)

- Hot Mix AC
- Warm Mix AC
- Plain PXX
- CRCP
- HIR
- CIR

Energy (BTU/T (m))
Project Background – Location
You're running a fever. Take two aspirin and lay off the carbon dioxide.
Project Background –
Patient’s Condition Prior to CIR
Investigations (Coring and Drilling)
Strength Dosage (pavement Structural Design)

Figure 5-2. Distribution of pressures under single-wheel loads
Treatment Options Eliminated
- Overlay
- Mill and inlay
- Hot In-place Recycling (HIR)

Treatment Options Considered
- Full Reconstruction
- Widen and Overlay
- Cold In-place Recycling (CIR)
Project Background – Life Cycle Cost Analysis

\[ NPV = I.C. + \sum_{k=1}^{N} R.C. \cdot \left( \frac{1}{(1+i)^{n_k}} \right) \]

- Initial Cost
- Recurring Costs
- Number of Recurring Costs
- Discount Rate
- Number of Years
- Net Present Value
Results of LCCA

- CIR had the
  - Lowest initial as well as Total Present Worth Cost
- Selected Treatment
**Additional Benefits of CIR**

- **GHG Emissions (lb CO₂/T)**
- **Energy (BTU/T (m))**

*(Chehovits and Galehouse)*
<table>
<thead>
<tr>
<th>Properties</th>
<th>Mix</th>
<th>Specifications</th>
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</thead>
<tbody>
<tr>
<td>Expanded Asphalt Cement added (%)</td>
<td>1.00%</td>
<td>1.0% Minimum</td>
</tr>
<tr>
<td>ITS- Dry(min)</td>
<td>346.6</td>
<td>300.0 kPa Minimum</td>
</tr>
<tr>
<td>ITS- Wet(min)</td>
<td>286.8</td>
<td>150.0 kPa Minimum</td>
</tr>
<tr>
<td>Retained ITS (%) min</td>
<td>82.70%</td>
<td>50% Minimum</td>
</tr>
<tr>
<td>Selected Moisture Content (% added to mix)</td>
<td>5.36%</td>
<td>-</td>
</tr>
<tr>
<td>Bulk Rel. Density (Mg/m³)</td>
<td>2.06%</td>
<td>-</td>
</tr>
<tr>
<td>Maximum Rel. Density (Mg/m³)</td>
<td>2.44%</td>
<td>-</td>
</tr>
<tr>
<td>Air Voids (%)</td>
<td>15.80%</td>
<td>-</td>
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</table>
Preparing for the CIR Process (Deep Patch Repair)
The Operation Equipment

- Wirtgen 3800 CR
  - Milling Width 3,800mm
  - Milling Depth 0-150mm
  - Rated Power 950HP
  - Number of teeth 294
The Operation Itself
The Challenges During Operation
Overcome the Challenges
Overcome the Challenges
Post Treatment Testing –
Material Testing
The first Municipality in Canada to implement the pavement smoothness specifications

- Smooth Roads are Green
Pavement roughness had a significant impact on fuel consumption of trucks applying loads to WesTrack pavement test sections. Under otherwise identical conditions, trucks used 4.5% less fuel on smooth (post rehabilitation) than on rough (pre rehabilitation) pavement.

- NCHRP Report 455, p. 483

Courtesy of Gerry Huber (Heritage Research Group, Indianapolis, Indiana)
### Smooth Roads are Green

**2009 NHS**
- 40% of All Traffic
- 75% of All Freight Traffic

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mileage of NHS</th>
<th>~Km Traveled</th>
<th>CO$_2$e($^*$)</th>
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</thead>
<tbody>
<tr>
<td>Poor</td>
<td>8%</td>
<td>11%</td>
<td>8% additional</td>
</tr>
<tr>
<td>IRI &gt; 2.69 m/km</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td>66%</td>
<td>69%</td>
<td>Net 0%</td>
</tr>
<tr>
<td>Good</td>
<td>26%</td>
<td>20%</td>
<td>3% savings</td>
</tr>
<tr>
<td>IRI ≤ 1.50 m/km</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Courtesy of Gerry Huber (Heritage Research Group, Indianapolis.)*
Post Treatment Testing – Smoothness Testing

- Pre-Construction (May 19, 2011)
- Post CIR (July 6, 2011)
- Post Surfacing (July 18, 2011)
- After one Winter (May 11, 2012)
Post Treatment Testing – Smoothness Testing

- Pre-construction, May 19, 2011
- Post-CIR, July 6, 2011
- Post-surfacing, July 18, 2011
- After one winter, May 11, 2012
Post Treatment Testing – Ground Penetrating Radar Survey

Station (km)

Depth (mm)

Asphalt Concrete
Granular Base
Post Treatment Testing – Falling Weight Deflectometer Testing

- Pre-construction Subgrade Modulus
- Post-construction Subgrade Modulus
Post Treatment Testing – Falling Weight Deflectometer Testing

- Pre-construction Pavement Modulus
- Post-construction Pavement Modulus
Post Treatment Testing – Falling Weight Deflectometer Testing

Effective Structural Number

- Pre-construction Effective Structural Number
- Post-construction Effective Structural Number

Chainage (m)

Effective Structural Number
Post Treatment Testing – Falling Weight Deflectometer Testing

- Average Deflection at Sensor 1 (um): Pre-Construction 310, Post-Construction 305
- Average Subgrade Modulus (MPa): Pre-Construction 40, Post-Construction 44
- Average Pavement Modulus (MPa): Pre-Construction 1428, Post-Construction 740
- Average Effective Structural Number: Pre-Construction 87, Post-Construction 115
Where
\[ d_o = 1.5pa \left\{ \frac{1}{MR} \sqrt{1 + \left( \frac{D}{a} \sqrt{\frac{E_p}{MR}} \right)^2} + \frac{1}{\sqrt{1 + \left( \frac{D}{a} \right)^2}} \right\} \]

- \( d_o \) = deflection at the centre of the load plate
- \( p \) = load plate pressure
- \( a \) = load plate radius
- \( D \) = total thickness of the pavement layers
- \( MR \) = Subgrade resilient modulus
- \( E_p \) = Effective Modulus of all the pavement layers
Post Treatment Testing – Visual Performance of the Condition

2011.05.18

2012.05.22
Post Treatment Testing – Visual Performance of the Condition
Post Treatment Testing –
Visual Performance of the Condition

2013.02.03

2013.02.03
Summary and Conclusions

- Very poor condition of 144 Ave
- Evaluated different alternatives
- The first ever CIR in the City of Calgary Selected
- The process Went Extremely Well
- Performing Extremely Well in terms of smoothness, Surface and Structural condition
- GPR Survey should be carried out for proper Design
CITY OF CALGARY HAS

14,000 Centreline Kilometres

46,000 Lane-Kilometres of roads

Adding new roads each year

The history goes back to more than 100 years

That's all for now
Thank You!

Questions...