“An Overview of Low Cost Pavement Alternatives in Canada”

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Acknowledgement

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Outline

• Canada road network
• Low volume & rural road standards
• Decision factors in selection of low-cost pavements
• Low cost pavement alternatives
• Selection of surface rehabilitation techniques
• Concluding remarks
Canada Road network

- Total of 1,042,300 km (647,700 mi) of roads in Canada
  - 415,600 km (258,200 mi) are paved
  - 626,700 (389,500 mi) are unpaved
- 17,000 km (11,000 mi) of expressways
  - Third-longest in the world, behind the Interstate Highway System of the United States and the China’s National Trunk Highway System
- Low volume roads (rural roads – paved and unpaved) constitute 70% of Canada’s road network [TAC 2011].

...Let us discuss **Low-Volume Roads** before

.......we discuss Low-Cost Pavements
Low Volume Roads Classification

- Generally between 200 and 400 AADT
- Rural Road System
  - Access to farms, residences, businesses or other properties
  - Traffic: cars, local light and medium vehicles and occasional heavy trucks
- Recreational Roads
  - Primary roads, which connect to the external road network, perimeter roads around the recreation area
  - Traffic: trailers, camper-truck units, cars
- Resource Development Roads
  - Resource related roads such as oil & gas, forest, mining roads
  - Traffic: heavy loaded vehicles, oversized/long

Low-Cost alternatives are typically considered on these roads
Where Low Cost Pavements are Applicable

- Where funds are limited and rural traffic volumes are very low, undertaking the minimum possible work to achieve **basic vehicle access**, makes sense & develops communities

- Surface upgrades are considered when
  - Low traffic volume but need to provide **dust-free/smooth surface**
  - Low traffic volume but with **heavy vehicle traffic** – resource development roads
  - Major effect of climatic factors (**freeze-thaw**)
  - **High maintenance cost** of unpaved roads
  - If a LCCA is considered, it generally includes maintenance cost over its service life
<table>
<thead>
<tr>
<th>Decision Factor</th>
<th>Consideration</th>
</tr>
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</table>
| Traffic                             | • Vehicles per day *(AADT)*  
• Volume of **commercial vehicles** of different types  
• Vehicle operating speed and terrain type  
• Expected growth in traffic volumes  
• Road user costs  
• Road **functional classification**                                                                 |
| Design Life                         | • Expected **service life**  
• Operating and maintenance budget availability                                                                                               |
| Impact on Local Residents           | • Impact on the environment (Sound, dwelling units near roadway, dust, flying aggregates, ride, community expectations)                      |
| Impact on Local Business Activities | • Presence of large truck trip generators such as **forestry and mining activities**  
• Impact of **spring load restrictions** a local business activities  
• Number of retail stores along the route                                                                                     |
| Impact on Long-Distance Travel      | • Proportion of trips that have both the origin and destination outside the local business area  
• Impact of **spring load restrictions** on long-distance commerce  
• The need for alternative transportation corridors.                                                                 |
| Agency Costs (Capital, Operating and Maintenance) | • **Initial construction costs** for pavements, and highway and bridge improvements  
• Routine **maintenance and winter maintenance costs**  
• Future rehabilitation costs (**LCCA**)  
• Pavement performance and constructability issues                                                                 |
## Low Cost Pavement Alternatives Matrix

<table>
<thead>
<tr>
<th>Surface Type</th>
<th>Unpaved</th>
<th>Stabilized</th>
<th>Paved</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment Type</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravel Surface</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Reinforced - Geogrid/Geocell/Geomembrane</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Surface T treated (Asphalt/Cement/Lime)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Asphalt</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Cement</td>
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<td>✓</td>
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<tr>
<td>Lime</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Thin Overlay (Hot/Cold/Recycled)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Micro-Surfacing/Slurry Seal</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Seal Coat</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Surface Course</strong></td>
<td>x</td>
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<td>✓</td>
</tr>
<tr>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td><strong>Granular Base Course</strong></td>
<td>O</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>O</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Granular Sub-Base Course</strong></td>
<td>x</td>
<td>O</td>
<td>✓</td>
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<tr>
<td>O</td>
<td>O</td>
<td>O</td>
<td>✓</td>
</tr>
</tbody>
</table>

X = Not Applied  ✓ = Applied  O = Optional
Unpaved Roads – Gravel Surface

• Description
  • One or more layers (50-300 mm) of compacted crushed gravel placed directly on existing or prepared subgrade

• Advantages
  • Proven performance in rural areas, **gravel-rich environments**
  • Usually lower initial cost than most other surfacing options
  • As an intermediate surface in ‘staged construction’ strategy

• Disadvantages
  • **High maintenance** costs; particularly for re-gravelling. It needs a sustained maintenance program
  • Dust pollution in dry weather
  • Traffic, climatic and longitudinal gradient (>6%) constraints on use relating to rate of gravel loss
Enhanced Gravel Roads

Reinforced with Geogrid or Geocell
- Application similar to gravel roads
- But reinforced with geosynthetics – geogrid, composite geogrid, geocell
- Can use in-situ (local) material
- Improves strength and performance
- Suitable on moderate-weak subgrade
- About $80,000-90,000/km; $11/m²

Surface Treated Gravel Roads
- 50-100 mm of gravel treated with asphalt, cement or lime treated
- Decrease dust levels
- Improves ride quality
- Retains the profile
- Durable
- About $70,000/km - $8/m²
Stabilized Soil – Pavements

• **Description**
  - Stabilization consists of improving the properties of pavement *base course*, *sub base-course* and/or *sub-grade* by the use of cement, lime or asphalt (bitumen) uniformly mixed, moistened, compacted, finished and cured
  - Soil Stabilization is intended for soils with more than 35% silt or clay (material passing a No. 200 (75um) sieve)
  - Thickness varies 150 – 300 mm, road mix operation or central plant mix

• **Types of Stabilization**
  - Portland Cement (7-14%), Bitumen (3-7%) and Lime (7-14%)

• **Advantages**
  - Increases load bearing capacity
  - Upgrades locally available marginal materials
  - Less susceptible during spring thaw
  - Decreases plasticity, provides a stable working platform
  - Reduces dust in work environment
  - Reduction of pavement thickness
Low Cost Paved Roads

- Thin Asphalt Concrete (AC) Surface Course (≤40 mm)
- Seal Coat (Chip seal)
- Micro-Surfacing/Slurry seal
- Rehabilitation Options
  - Restorative Seal
  - Texturization
  - Hot-in-Place Recycling (HIR - total depth of re-processed and new material of <40 mm)
**Thin Asphalt Concrete Surface Course**

**Description**
- Surface course ≤ 40 mm made of **hot, cold or recycled asphalt concrete** material
- Typically placed on granular base course
- Do not contribute substantially to the structural strength of the pavement

**Benefits**
- Provides **smooth, durable, dust-free surface**
- Seal the pavement surface from the intrusion of water
- Reduce noise from friction pavement-tire

**Canadian Agencies Experience:**
- City of Ottawa: ultra-thin overlay typically 15 to 20 mm thick, contains an open-graded high quality aggregate passing the 13.2 mm sieve size
- City of Montreal: Overlay ranging in thickness from 13 to 30 mm
- Counties of Leeds and Grenville (ON): Ultrathin overlay of 12 mm thick
- Two main types of hot mix are used for thin overlays: polymer-modified dense-graded and open-graded mixes. Typically use sandy mixes with the largest aggregate particle passing the 13.2 mm sieve
Construction Sequence for Thin Mix Overlays

1. Optional vibratory dual steel drum rollers
2. Rubber tired rollers
3. Static dual steel drum rollers

Optional material transfer vehicle
Hot mix truck
Asphalt distributor
Power broom
Milling machine

Optional built-in tack coat application
Tack coat application
Seal Coat

• Description
  • Seal Coating (or surface seal or chip seal) is the application of emulsion immediately followed by an application of cover aggregate.
  • Seal Coat applied on top of asphalt concrete pavements as preventive or treatments or
  • Used to seal the granular surface layer to provide smoother wearing surface, prevent moisture ingress, reduce dust.

• Canadian Agencies Experiences
  • Alberta Transportation & Ontario Ministry of Transportation has applied Seal Coat as a viable pavement preservation strategy for asphalt concrete pavements.
  • Saskatchewan Ministry of Transportation uses double seal coat on granular base layers.
  • Other experiences of using this on stabilized base course, in-place recycled surfaces (FDR/CIR).
Seal Coat Application Procedure

1. Applying Emulsion 1.5 - 1.9 L/m²
2. Spreading Aggregates
3. Roller Compacted
4. Finished Product
Micro-Surfacing / Slurry Seal

• **Description**
  - Micro-Surfacing is an unheated mixture of polymer-modified asphalt emulsion, high-quality frictional aggregate, mineral filler, water, and other additives,
  - Mixed and spread over the pavement surface as slurry to correct surficial distresses or provide a wearing course to a depth of up to 15 mm
  - Slurry Seal is similar to micro-surfacing, but the mineral skeleton is typically not very strong and has limited interlocking of the aggregate particles, thickness of up to 40 mm

• **Canadian Agencies experience:**
  - City of Halifax: micro-surfacing on top of surface treatment (chip seal). It performs well and can be used to correct bleeding problems caused by the loss of cover aggregate
  - City of Saskatoon has replaced its previous slurry sealing program with a micro-surfacing program because of better cost-effectiveness of micro-surfacing. The 95% of micro-surfacing treatments placed on residential streets, after a following of five years still in good condition.
  - Ontario Ministry of Transportation have developed micro-surfacing specifications that include a 2-year warranty
  - City of Calgary: uses Microsurfacing as a preventative maintenance alternative
Construction Process of Micro-Surfacing
Selection of Surface Rehabilitation Techniques to Protect the Pavement Structure

<table>
<thead>
<tr>
<th>Protecting Pavement Structure Against:</th>
<th>Penetration of water</th>
<th>Loss of aggregate and ravelling</th>
<th>Hardening of bituminous binder and oxidization</th>
<th>Environment and traffic Exposure</th>
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<tbody>
<tr>
<td><strong>Thin Pavement Surfacing</strong></td>
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<td>Thin overlay</td>
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<td>HIP recycling</td>
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<td>Surface treatment</td>
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<th>Type of facility</th>
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<th>Arterial</th>
<th>Local</th>
<th>Arterial</th>
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○ A possibility  ● Should be considered  ●● Typical application

Source: Preservation of Bituminous Pavement using thin Surfaces restoration techniques
# Selection of Surface Restoration Techniques to Provide a Wearing Surface

<table>
<thead>
<tr>
<th>Thin Pavement Surfacing</th>
<th>Providing Surface on:</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Granular base</td>
<td>Surface treatment</td>
</tr>
<tr>
<td>Thin overlay</td>
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<td>•</td>
</tr>
<tr>
<td>HIP recycling</td>
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</tr>
</tbody>
</table>

- **A possibility**
- **Should be considered**
- **Typical application**

*Source: Preservation of Bituminous Pavement using thin Surfaces restoration techniques*
Every technique has a particular role in new construction or preventive maintenance (corrective action are too late) and are to be applied at a network level, as part of pavement management system and on a project level as detailed evaluation of alternatives for specific projects.
# LCCA in Considerations for Selecting Surface Type

<table>
<thead>
<tr>
<th>LCCA – Consideration</th>
<th>Gravel</th>
<th>Stabilized</th>
<th>Paved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial cost</td>
<td>L</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>Maintenance cost</td>
<td>H</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Rehabilitation cost</td>
<td>L</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>Service life</td>
<td>L</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>Level of service</td>
<td>L</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>Structural capacity</td>
<td>L</td>
<td>M</td>
<td>H</td>
</tr>
</tbody>
</table>

**L**: Low  **M**: Medium  **H**: High
Concluding Remarks

• Low volume roads are extremely important for social and economic development in Canada

• Cost information is highly variable depending on site considered and type of road to be constructed or treated

• Local experience, cost and requirements governs treatment selection

• Selection of optimal solution requires a LCCA
Thank you!

Contact:

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