





#### Impact of Alternative Deicing Chemicals on Asphalt Pavements

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# Problem Definition and Background

- Past Runway de-icing typically done using Urea
  - Adverse environmental impact
- Airports shifted towards environmentally friendly products
  - Alternatives Potassium Acetate, Sodium Acetate, Sodium Formate, Potassium Formate
  - DND switched to Potassium Acetate and Sodium Formate in late 1990s
- Impact of new de-icing chemicals on Long-term Pavement Performance (LTPP) unknown





#### Problem Definition and Background (continued)

- Some airports reported an increase in pavement durability problems
  - degradation and disintegration of asphalt pavement
  - softening of asphalt binder
  - stripping of asphalt mixes occurring together with ravelling
- General consensus of research to date indicated good quality asphalt is not adversely affected <u>but</u> the history of use is still relatively short and the impact on lesser quality asphalts is not fully understood



## **Field Performance**

- In the years leading up to this study, we saw rapid deterioration
  - RWY 08-26 in Goose Bay, NFLD
  - RWY 12-30 in Greenwood, NS
- Both runways had an underlying stripping (moisture sensitivity) condition
- Runway de-icing chemicals possibly contributed to and/or accelerated the resulting stripping damage





# 5 Wing Goose Bay Main Runway 08-26

Last rehab in 2007 - No hydrated lime/liquid anti-strip - TSR = 80%

PCI = 69 in 2013

- Low severity raveling, extensive cracking
- Delaminations







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# 14 Wing Greenwood Crosswind Runway 12-30

Last rehab in 2001 - No hydrated lime/liquid anti-strip - TSR = 94%

PCI = 58 in 2019; 61 in 2021 (after extensive patching)

- low to med severity ravelling
- secondary cracking on longitudinal (paver lane) joints/cracks

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- slippage cracking

Defence





# 14 Wing Greenwood Main Runway 08-26

Last rehab in 2000 - 1% hydrated lime

Grooved in 2017

PCI = 78 in 2021

- very few distresses

- low to med severity longitudinal cracking, weathering





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#### **Pavement Investigation**

- Contracted Englobe to investigate issue in 2019
- Started as a single phase but added second phase to expand scope





#### **Sites Investigated**

Phase 1 (2019-2020)

- 3 Wing Bagotville, QC RWY 11-29 (2008) & RWY 18-36 (1984)
- 4 Wing Cold Lake, AB RWY 13L-31R (2006) & RWY 04-22 (2002)
- 8 Wing Trenton, ON RWY 06-24 (2000)
- 14 Wing Greenwood, NS RWY 08-26 (2000, grooved in 2017) & RWY 12-30 (2001)

#### Phase 2 (2012-2021)

- 5 Wing Goose Bay, NFLD RWY 08-26 (2007) 2020, RWY 16-34 (1990) & TWY P (1991)
- 12 Wing Shearwater, NS Helipad 16-34 (2008)
- 15 Wing Moose Jaw, SK RWY 11L-29R (2009)
- 4 Wing Cold Lake, AB TWY M (2020, bulk samples)
- 14 Wing Greenwood, NS RWY 12-30 Button (2020, bulk samples)

\*Dates in brackets indicate year of last major rehab/overlay.







#### Mix Investigation Methodology

- Review of HMA Designs
- Visual Examinations of Pavement at core locations
- Removal of 150 mm diameter cores
- Measurement of Core Compaction
- Marshall, Petrographic, Absons and Pen
- Modified Lottman Testing
- Conditioning in Potassium Acetate or Sodium Formate
- APA Testing of Cores and Bulk Samples



#### **Asphalt Pavement Analyser**







## Test Results - TSR Bulk Samples

Runway 08-26 Goose Bay - Surface HMA with 1 % Hydrated Lime

- Water Conditioned: TSR 95.4 %
- KA Conditioned: TSR 87.3 %
- NaF Conditioned: TSR 86.1 %

Reduction of 8 to 9 % in TSR due to Deicers - still greater than 85 % minimum





## Test Results - TSR Bulk Samples

Button 12 Greenwood - HMA with Hydrated Lime

- Water Conditioned: TSR 90.3 %
- KA Conditioned: TSR 93.1 %
- NaF Conditioned: TSR 87.8 %

Slight Reduction of 2.5 % in TSR due to NaF - still higher than the 85 % minimum





## Test Results - TSR Bulk Samples

Taxi Mike Cold Lake - Surface HMA with 1 % Hydrated Lime

- Water Conditioned: TSR 96.4 %
- KA Conditioned: TSR 94.1 %
- NaF Conditioned: TSR 95.2 %

Slight Reduction of 1.2 to 2.5 % in TSR due to Deicers - still higher than 85 % minimum





## Test Results - TSR Core Samples

Runway 12-30 Greenwood - HMA with no anti-strip

- Water Conditioned: TSR 99.6 %
- KA Conditioned: TSR 27.5 %
- NaF Conditioned: TSR 51 %

Reduction of 48 to 72 % in TSR due to Alternative Deicers





## Test Results - TSR Core Samples

Runway 08/26 Greenwood - HMA with 1 % Hydrated Lime

- Water Conditioned: TSR 95.0 %
- KA Conditioned: TSR 74.4 %
- NaF Conditioned: TSR 87.7 %

Reduction of 7 to 20 % in TSR due to Deicers





#### Test Results - APA Bulk Samples

Runway 08/26 Goose Bay - Surface HMA with 1 % Hydrated Lime

- Water Conditioned: 5.3 mm
- KA Conditioned: 6.5 mm
- NaF Conditioned: 6.2 mm

Increase in APA Rutting of 17 to 23 % due to Deicers - slightly higher than 5 mm limit





#### Test Results - APA Bulk Samples

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Button 12 Greenwood - Surface HMA with 1 % Hydrated Lime

- Water Conditioned: 2.5 mm
- KA Conditioned: 3.9 mm
- NaF Conditioned: 3.7 mm

Increase in APA Rutting of 48 to 56 % due to Deicers - still less than 5 mm limit



#### Test Results - APA Bulk Samples

Taxi Mike - Surface HMA with 1 % Hydrated Lime

- Water Conditioned: 1.7 mm
- KA Conditioned: 2.8 mm
- NaF Conditioned: 2.4 mm

Increase in APA Rutting of 41 to 64 % due to Deicers - still less than 5 mm limit





Hydrated Lime application to milled surface of stripped asphalt





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#### **Tack Coat**

-proper dosing and application



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#### Proper Laydown



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#### **Proper Jointing**

**Joint Heaters** 







# **Proper Compaction**





#### **Aramid Fibres**

#### CFB Trenton 2021





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#### Conclusions

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- TSR testing of mixes without hydrated lime indicated higher levels of stripping when mixes were exposed to alternative deicers during testing
- Testing indicated no difference in moisture-susceptibility between alternative chemicals
- TSR and APA testing of mixes incorporating hydrated lime, conditioned in alternative deicers indicated significantly lower levels of stripping compared to mixes that did not contain hydrated lime



#### **Recommendations**



- Continued Use of Hydrated Lime @ 1 % (originally intended to address stripping) to also mitigate damage caused by alternative deicing chemicals
- Adopt TSR limits of 85 % minimum plus
  Visual Stripping Rating of 4 or less
- Additional testing to assess interlayer bonding and required mitigation
- Additional testing/field trials to check impact of aramid fibres on mix performance (including stripping) when exposed to alternative deicing chemicals
- Include use of APA or Hamburg Rut and Moisture-Susceptibility Tester to validate mixes prior to paving





#### 25 - Year Expected Pavement Life







