Drainage Renewal and Pavement Rehabilitation

Which should come first?

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Strategic Asset Management Engineer
Opus International Consultants
Introduction

• As early as 1820, John McAdam noted that, regardless of the thickness of the structure, many roads in Great Britain deteriorated rapidly when the subgrade was saturated.
Pavement Design (Drainage)

- Prevent moisture from entering
  - Waterproof surface and shoulder
  - Longitudinal drains (lined/unlined channels and side drains)
  - Adequate cross slope and longitudinal grades (crossfall and gradient)
- Use moisture insensitive materials (few fines)
- Remove moisture that enters
  - Subsoils
• Exponential relationship between saturation and rate of rut development in granular basecourse.
• Equilibrium saturation ~60%
• Finite element models show once basecourse infiltrated, can take weeks for water content to return to equilibrium.

www.nzta.govt.nz/resources/research/reports/555/index.html
# Research Report 555 - Scorecard

<table>
<thead>
<tr>
<th>Surface drainage scorecard</th>
<th>High</th>
<th>Med</th>
<th>Low</th>
<th>Score</th>
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<tbody>
<tr>
<td>Climate</td>
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<tr>
<td>Rainfall</td>
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<tr>
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<td><strong>Total</strong></td>
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</table>
• Recommendations
  – Drainage risk score included in RAMM
  – RAMM Drainage condition rating carried out for high risk sections
  – Rut rates monitored as standard process for subsoil deficiency or blockage.
The Relationship between Traffic Loading and Environmental Factors to Low Volume Road Deterioration. (Henning, Alabaster, Arnold & Liu (93rd TRB Conf.))

- LTPP data
- Rut progression dependant upon
  - Moisture sensitivity
  - Drainage adequacy
  - ESA

[Graph showing relationship between traffic loading and rut progression]

docs.trb.org/prp/14-2372.pdf
Current Ongoing Research

- NZ Transport Agency seek assistance in developing business cases for asset renewal
- Forecasting renewal need for drainage

Investing more in drainage needs and programming drainage works well ahead of resurfacing/renewals will prolong the life of the existing pavement
Objectives & Collaboration

- Develop robust short term plan (FWP – 5yr)
- Understand long term funding needs
  - **Opus Surface Model**
    - Empirical - Stochastic
  - **Geosolve Subsurface Model**
    - Mechanistic - RPP
  - Pilot Area SH2 Napier to Wairoa using national data only
Drainage Treatment Lengths (DTL)

• Build on RR555 Drainage Risk Scorecard
• Similarly performing (homogenous)
  – Existing drainage asset?
    • RAMM Inventory (side, type (lined, unlined, none))
  – Moisture sensitivity?
    • Soil Type (RPP structural sections)
  – Moisture susceptibility?
    • Topography (LIDAR not included)
    • Geometry (crossfall and gradient)
    • Cut or Fill
DTL - Moisture Susceptibility

CUT SLOPE

FILL SLOPE

- Natural Ground
- Shoulder
- Taveled Way
- Subgrade
- Surface Course
- Base Course
- Fill Slope (Embankment)
- Ditch
- Cut Slope (Back Slope)
Stochastic Example

- Condition Variable/Index

NZ Mood

- Asset Groups

| Day After Big Game | Any Other Day |

- Condition Bands

- Transition Probability Matrix (TPM)
  - Change over discrete period of time
## Stochastic Example

<table>
<thead>
<tr>
<th>Any Other Day</th>
<th>Day After Big Game</th>
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<tbody>
<tr>
<td><strong>Today</strong></td>
<td><strong>Tomorrow</strong></td>
</tr>
<tr>
<td>80%</td>
<td>19%</td>
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<tr>
<td>50%</td>
<td>45%</td>
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<tr>
<td>25%</td>
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</table>
Surface Model - Stochastic

- **Index**: 0 (no need) to 10 (high need)
  - Rut Differential (RAMM HSD)
    - Weighted by Traffic
  - Rainfall (NIWA)
    - Weighted by Geology
  - Geometry (RAMM HSD)
- **Asset Groups** (type, cut/fill)
- **Condition Bands**
  - 5 bands even
- **Treatments**
  - Full (include subsoils)
  - Major (re-grade only)
Subsurface Model - Mechanistic

- FWD & TSD Data
- Pavement Deflection
  - Dry: High Vertical, minimal Lateral
  - Wet: Vertical = Lateral
- Index 0 (no need) to 5 (high)
  - Subgrade Modulus (CBR)
  - Non-linearity of subgrade
  - Lateral deformation
  - Rut differential (LWP/RWP)
Subsurface Hot Spot Tool
Next Steps

- **Trial 2:** Northland NOC network, compare outputs ‘on road’ for logic improvement include resets.
- **National Analysis:** Business case justification for Drainage Renewal.
- **Cross Asset Optimisation alongside Pavement & Surfacing models.**