Flinders Highway foam bitumen stabilisation project: Richmond to Julia Creek

Damian Volker | Pavements Rehabilitation, Engineering and Technology
Srikanthan Kanapathippillai | North West District, Program Delivery and Operations
Located half way between Richmond and Julia Creek

Approximately 6 hours west of Townsville
Also known as the middle of nowhere
Or ... 400 km in either direction to the nearest McDonalds
With these ingredients, we turned …

This into This!
Background

Significant pavement failure:

• The pavement was rapidly deteriorating with increased roughness/rutting that required rehabilitation.

• Fatigue was due to:
  - repeated cement stabilisation
  - weak subgrade
  - increased traffic loading.
$1.72 million saved in optimising additive contents

Plus further savings from increased productivity (20% increase in area per bitumen tanker load)
How were these savings achieved?

Through rigorous laboratory testing performed at our labs

**Townsville**
Unconfined Compressive Strength (subgrade)

**Herston**
Modulus testing (foamed bitumen base)
With help from the department’s Townsville lab, we optimised the lime required for subgrade from 8% to 5%.

A saving of $1.36M over 14 km
With help from the department’s Herston lab, we optimised the bitumen required from 3% to 2.5%.

A saving of $26,000/km
So, what materials did we start with?
Existing pavement profile

- 150mm Cement Treated Base (CTB)
- 100mm Sandy fill (CBR 5)
- Black soil (CBR 1)
Subgrade – California Bearing Ratio (CBR) – less than 1%

<table>
<thead>
<tr>
<th>Sample Details</th>
<th>Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample ID: GARB13S-02178</td>
<td>CBR (%): 0.6</td>
</tr>
<tr>
<td>Date Sampled:</td>
<td>CBR at 2.5 (%): 0.6</td>
</tr>
<tr>
<td>Date Submitted: 16/08/2013</td>
<td>CBR at 5.0 (%): 0.6</td>
</tr>
<tr>
<td>Date Tested:</td>
<td>Nominated MDD (t/m³): 1.639</td>
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<tr>
<td>Project Location: Flinders Highway</td>
<td>Nominated OMC (%): 20.1</td>
</tr>
<tr>
<td>Sample Location: P43, Subgrade 1, Ch : 79000m, Offset : 3.3m L of CL</td>
<td>Achieved Moisture Content (%): 20.3</td>
</tr>
<tr>
<td></td>
<td>Achieved Dry Density (t/m³): 1.588</td>
</tr>
<tr>
<td></td>
<td>Soaked: Yes</td>
</tr>
<tr>
<td></td>
<td>Swell (%): 5.1</td>
</tr>
<tr>
<td></td>
<td>MC After Penetration of Penetrated End (%): 30.8</td>
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<tr>
<td></td>
<td>MC of Remainder (%): 26.8</td>
</tr>
</tbody>
</table>

![Force vs Penetration Graph](image-url)
Lime stabilised subgrade scenario designs

- Targeting 1.5 MPa @ 28 days
- 25% fill and 75% Blacksoil
- 50% fill and 50% Blacksoil
- Other scenarios included:
  - 25% gravel + 25% fill and 50% Black soil
  - 50% CTB and 50% Blacksoil
Foam bitumen base design

300mm Foam Bitumen layer

- 100mm new type 2.2 quarry material
- 150mm Reclaimed CTB
- 50mm lime stabilised subgrade
Material grading was achieved – and tested by Cloncurry Laboratory
Pavement strength test – Before and after

Maximum Deflection (D0)
FWD 40 kN Plate Load
14D

Reference Chainage (m)

Before

After
Post construction

• Post construction pavement coring and testing performed by department’s Herston lab.
Design summary

• These innovations and savings arise from rigorous laboratory and field research, and justify ongoing research.

• This ensures that the implementation of responsible innovation is based on sound laboratory research.
Construction overview
Existing pavement profile

Option for high deflection locations – subgrade treatment.

Existing pavement profile

150-250mm

Sub grade
Proposed treatment steps

This is achieved by the following steps:

- Windrow existing pavement of an average depth of 150mm to the side.
- Lime stabilised weak sub-base and subgrade to a depth of 350mm.
- Windrow back the original 150mm of pavement.
- Import 100mm of new granular material (Type 2.2).
- Foam bitumen stabilise a depth of 300mm (100mm new + 150 mm existing + 50mm of lime stabilised layer).
- Proposed lime percentage for sub-grade treatment – 8% (only 5% used).
- Proposed bitumen and lime percentage for foam bitumen – 2.5% C170 Bitumen and 2% Hydrated Lime.
Excavate/ side cast the top 150mm of existing pavement

Profile/Grader blade top 150mm off into windrow

windrow

100mm existing pavement material remains

Sub grade
Date & Time: Wed Jul 16 08:54:28 EST 2014
Position: -020.67140° / +142.39574°
Altitude: 161 m
Azimuth/Bearing: 277° N83W 4924mils (True)
Elevation Angle: -17.9°
Horizon Angle: +00.5°
Zoom: 1X
Spread rate 11kg
Dry mixing of lime for bottom 350mm section 5A
Wet mixing of lime Section 1B for bottom 350mm.
Date & Time: Sat Aug 2 13:50:55 EST 2014
Position: -020.66692° / +142.34829°
Altitude: 157m
Azimuth/Bearing: 195° S15W 3467mils (True)
Elevation Angle: -17.4°
Horizon Angle: +00.8°
Zoom: 1X
Depth check
Wet mixing of lime Section 1B for bottom 350mm
Lime stabilisation 350mm deep

Lime stabilise to 350mm

windrow

350mm

Lime stabilised subgrade

100mm existing

250mm Black soil
Completed lime stabilised subgrade layer
Reinstate old CTB material (150mm)
Import 100mm new Type 2.2 quarry material

Overlay with 100mm Type 2.2 import Quarry material

- Import Type 2.2 Quarry material
- Existing/Reclaimed pavement material
- Lime stabilised subgrade

Target 1.5MPa @ 28 days

100mm
150mm
250mm
350mm
350mm
Spread 2% lime for foam bitumen layer

Incorporate lime
Incorporating foam bitumen, 300mm depth
Date & Time: Thu Jun 19 09:57:51 EST 2014
Position: -020.67357° / +142.41968°
Altitude: 156m
Azimuth/Bearing: 172° S08E 3058mils (True)
Elevation Angle: -16.2°
Horizon Angle: -00.2°
Zoom: 1X
Checking of depth
Completed foam bitumen stabilised base

Note: Cutting 50mm into the top of the lime stabilised subgrade interface by 50mm.
Date & Time: Wed Jul 9 10:30:06 EST 2014
Position: -020.66994° / +142.38038°
Altitude: 148m
Azimuth/Bearing: 094° S86E 1671mils (True)
Elevation Angle: -08.0°
Horizon Angle: +01.8°
Zoom: 1X
Seal section 10
Date & Time: Tue Jul 8 13:46:43 EST 2014
Position: -020.66780° / +142.35858°
Altitude: 156m
Azimuth/Bearing: 112° S68E 1991mils (True)
Elevation Angle: -03.0°
Horizon Angle: +01.9°
Zoom: 1X
Start seal section 12
Unleashing potential in North Queensland Region

Foam bitumen stabilisation and sub-grade treatment

- In North West District, the normal practice is to provide a corrector course of varying thickness ranging from 50mm to 75mm and then carry out cement stabilisation for a depth of 200mm.
Unleashing potential in North Queensland Region

Prior pavement rehabilitation treatments

• Premature failures are noted on the cement stabilised pavements due to weaker black soil subgrade specially on the outer wheel path.

Solution

• To improve pavement performance North West District wanted to try the innovative technique of foam bitumen stabilisation for this section including subgrade treatment.
Foam bitumen design

- Design life = 10 years.
- Design traffic = $1.1 \times 10^6$ Equivalent Standard Axles (ESAs).
- Granular material to be imported for overlay = 100 mm.
- Foamed bitumen base = 300 mm. (adopted for 1800 MPa for design purpose, however this modulus needs to be confirmed with mixed design results and adjusted accordingly).
- Granular buffer = Nil.
- Lime stabilised subgrade = 300mm. (adopted modulus = 200 MPa, Unconfined Compression Strength = 1.5MPa).
- Adopted design subgrade CBR = 2.
- Project reliability factor = 95%.
300mm foam bitumen
2.5% bitumen/ 2% lime

- 33% type 2.2
- 50% reclaimed pavement materials
- 17% Lime stabilised subgrade

300mm lime stabilised subgrade
5% lime

- 25% sandy fill
- 75% black soil
## Summary of cost

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Total Project Cost</td>
<td>$19,100,000</td>
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<tr>
<td>Actual Project Cost</td>
<td>$16,182,000</td>
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<tr>
<td>Total Length</td>
<td>14.44km</td>
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<tr>
<td>Width</td>
<td>9.0m</td>
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<tr>
<td>Area</td>
<td>129,960m²</td>
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<td>Cost / km</td>
<td>$1,120,637</td>
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<td>Cost / m²</td>
<td>$124.48</td>
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<td>Total savings</td>
<td>$2,918,903</td>
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<tr>
<td>Total Saving / m²</td>
<td>$22.46</td>
</tr>
</tbody>
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Breakdown of actual cost

- Contract Cost $12,158,000
- Principal Supplied Material (C170) $1,644,000
- RPO/SPO Cost $1,542,000
- Contract Administration (CGI) $598,000
- Other Principal Cost $240,000
Summary of actual cost
(excluding Regional Program Office, State Program Office and CGI Consulting cost)

Project cost would be $15,018,000
Cost /km $1,040,014
Cost /m2 $115.56

Current market cost similar type of treatment is $145/m2
(Foam bitumen -$95/m2 and subgrade treatment $50/m2)

Potential saving /m2 $29.44
Potential saving of $2,919,000 achieved mainly from:

- Hydrated lime percentage for the subgrade treatment reduced to 5% from the 8% (design value).
- Project can be delivered below the market price if we use the local resources.
- Management to consider Foam Bitumen Stabilisation an option as compared to the option of cement stabilisation provided local resources are used.
- C170 bitumen percentage for Foam bitumen reduced to 2.5% from 3% monitored through continuous modulus testing.
Thank you